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Air Pollution

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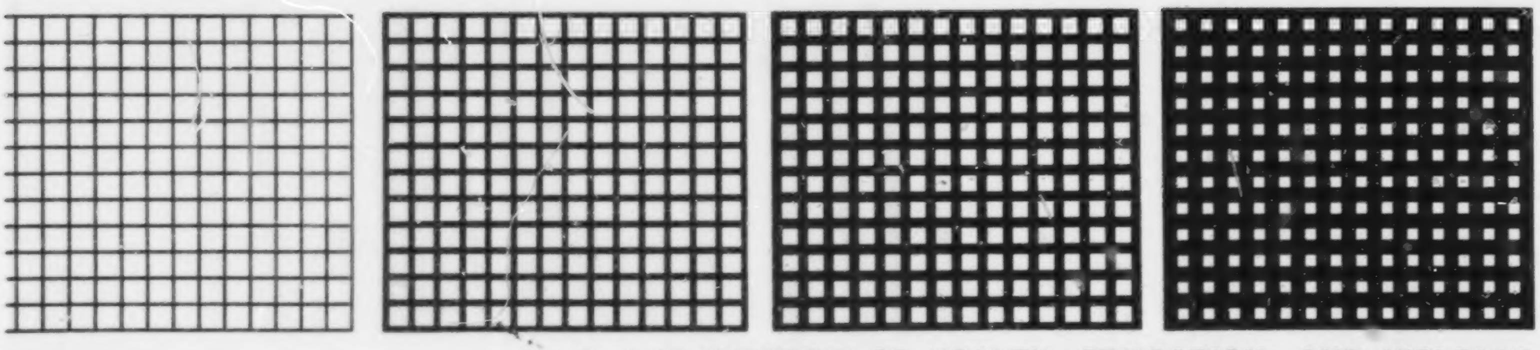
HANDBOOK OF AIR POLLUTION



U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service

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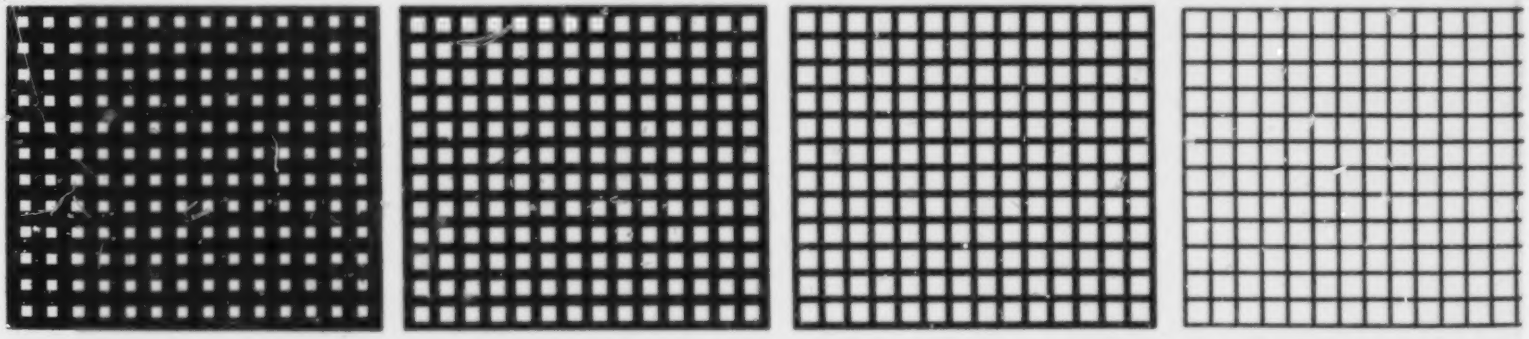
ABOUT THE COVER

The cover illustration represents the Ringelmann Chart, a method for the estimation of smoke density, which was developed by Professor Maximilian Ringelmann in Paris. Introduced into the United States in 1897, it now forms the basis of smoke emission legislation in over 100 American communities, and may be considered as a nationwide standard.

The Ringelmann Chart consists of a series of graduated shades of grey, varying in five equal steps from white (Ringelmann Number 0) to black (Ringelmann Number 5). The shades between are represented by standard grids; those reproduced on the cover are Ringelmann 1 through 4.



PB-190 247

HANDBOOK OF AIR POLLUTION

By

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TRAINING PROGRAM

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Bureau of Disease Prevention and Environmental Control

National Center for Air Pollution Control
Durham, N. C. 27701

The ENVIRONMENTAL HEALTH SERIES of reports was established to report the results of scientific and engineering studies of man's environment: The community, whether urban, suburban, or rural, where he lives, works, and plays; the air, water and earth he uses and reuses; and the wastes he produces and must dispose of in a way that preserves these natural resources. This SERIES of reports provides for professional users a central source of information on the intramural research activities of the Centers in the Bureau of Disease Prevention and Environmental Control, and on their cooperative activities with State and local agencies, research institutions, and industrial organizations. The general subject area of each report is indicated by the letters that appear in the publication number; the indicators are

AP - Air Pollution

RH - Radiological Health

UIH - Urban and Industrial Health

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PURPOSE OF HANDBOOK

Individuals working in the air pollution field often need access to data concerning the characteristics and behavior of air, gases and particles, and the chemistry of atmospheric pollutants, and to data of a general nature such as mathematics and common conversion factors. At present, to have access to all this information, the individual needs a wide variety of reference books. The Air Pollution Handbook was designed to consolidate the applicable portions of these numerous references into a single, easily accessible source.

The primary consideration for inclusion in the handbook is that the information be unlikely to change. This, then, excludes experimental results and data on air quality, even though these may be quite useful. The one exception to this general rule is the section on medical aspects. The experimental data that is included here is widely accepted in the field of biological experimentation.

It is not the intention of the authors that this handbook replace all other reference texts. It is designed to provide information of a general nature. For more specific data, an individual would refer to a more specialized text.

ACKNOWLEDGEMENT

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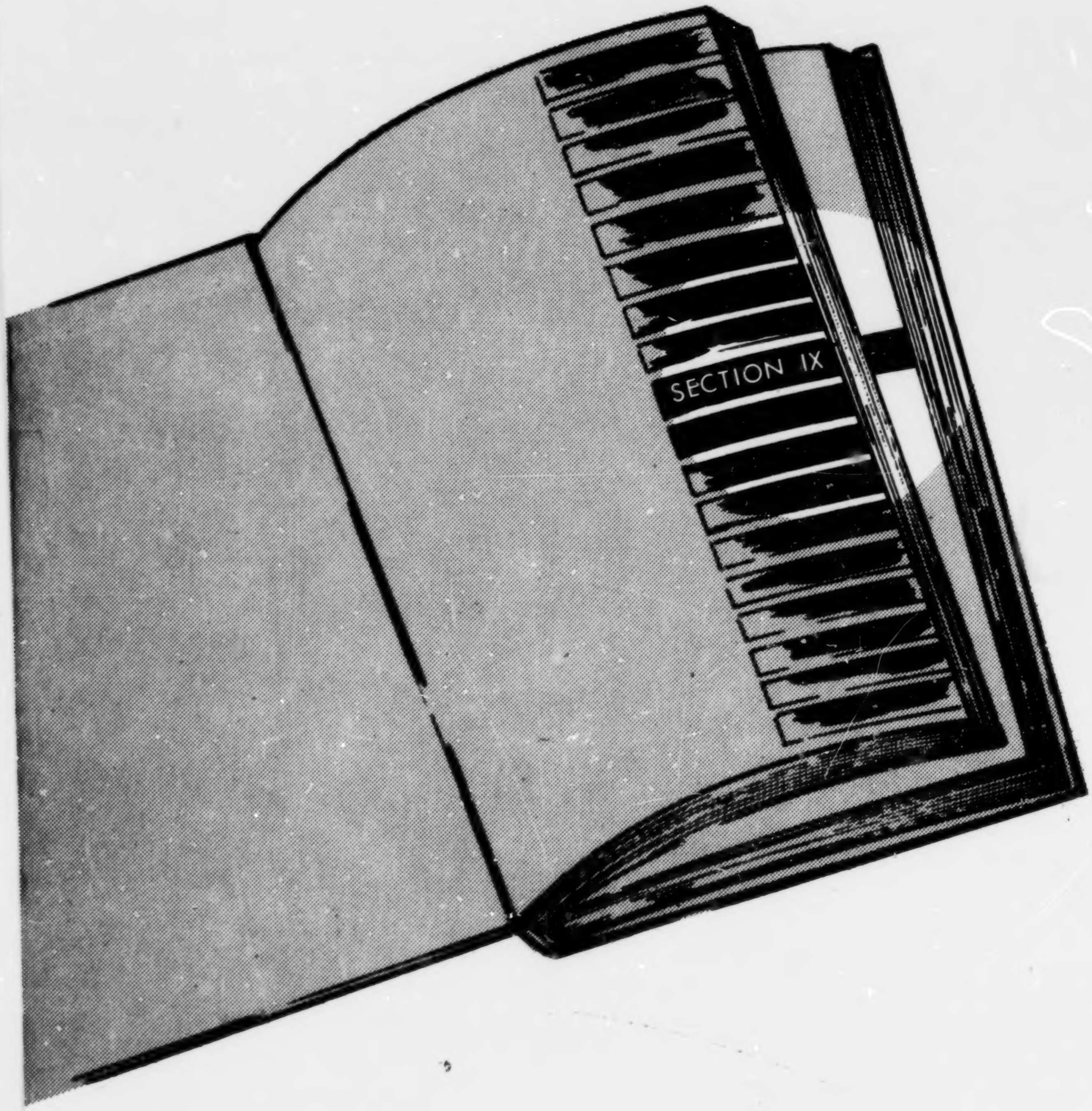
USE OF INDEX SYSTEM

To find the first page of any section in this handbook, bend back the pages after the Table of Contents as in the accompanying sketch. Select the page **whose black tab aligns with the desired section tab** located in the Index. The selected page will be the Section Divider for the section being sought.



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SIGNS AND SYMBOLS

+	plus, addition, positive
-	minus, subtraction, negative
±	plus or minus, positive or negative
∓	minus or plus, negative or positive
÷, /, —	division
x, ·, () ()	multiplication
() [ ]	collection
=	is equal to
≠	is not equal to
≡	is identical to
≅	equals approximately, congruent
>	greater than
≯	not greater than
≧	greater than or equal to
<	less than
≮	not less than
≦	less than or equal to
::	proportional to
:	ratio
~	similar to
∝	varies as, proportional to
→	approaches
∞	infinity
∴	therefore

√	square root
$\sqrt[n]{}$	nth root
a^n	nth power of a
$\log, \log_{10}$	common logarithm
$\ln, \log_e$	natural logarithm
e or ϵ	base of natural logs, 2.718
π	pi, 3.1416
∠	angle
⊥	perpendicular to
∥	parallel to
n	any number
$\lvert n \rvert$	absolute value of n
$\bar{n}$	average value of n
a^{-n}	reciprocal of nth power of a $= [\frac{1}{a^n}]$
n°	n degrees
n'	n minutes, n feet
n''	n seconds, n inches
f (x)	function of x
Δx	increment of x
dx	differential of x
Σ	summation of
sin	sine
cos	cosine
tan	tangent

GREEK ALPHABET

Alpha	Α	α	Iota	Ι	ι	Rho	Ρ	ρ
Beta	Β	β	Kappa	Κ	κ	Sigma	Σ	σ
Gamma	Γ	γ	Lambda	Λ	λ	Tau	Τ	τ
Delta	Δ	δ	Mu	Μ	μ	Upsilon	Υ	υ
Epsilon	Ε	ϵ	Nu	Ν	ν	Phi	Φ	ϕ
Zeta	Ζ	ζ	Xi	Ξ	ξ	Chi	Χ	χ
Eta	Η	η	Omicron	Ο	ο	Psi	Ψ	ψ
Theta	Θ	θ	Pi	Π	π	Omega	Ω	ω

PERIODIC CLASSIFICATION OF THE ELEMENTS

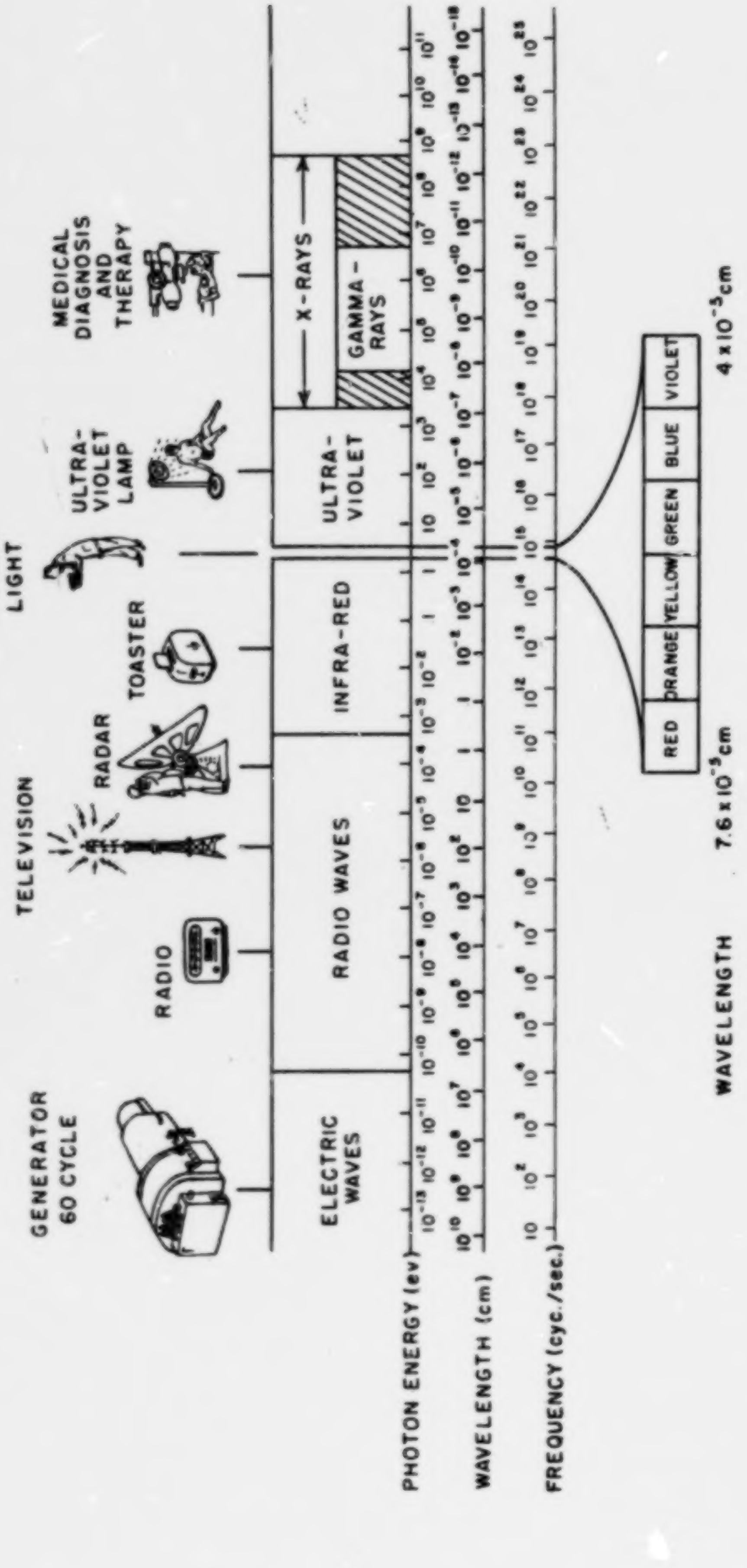
(BASED ON C^{12} = 12.000)

1 H 1.0080	2 He 4.003																2 He 4.003
3 Li 6.939	4 Be 9.012											5 B 10.81	6 C 12.011	7 N 14.007	8 O 15.9994	9 F 18.998	10 Ne 20.183
11 Na 22.990	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.974	16 S 32.064	17 Cl 35.453	18 Ar 39.948
19 K 39.102	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.71	29 Cu 63.54	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.909	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (99)	44 Ru 101.1	45 Rh 102.90	46 Pd 106.4	47 Ag 107.870	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.30
55 Cs 132.91	56 Ba 137.34	57 to 71	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.09	79 Au 197.0	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.98	84 Po (210)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.05	89 to 103															

Lanthanide series	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (147)	62 Sm 150.35	63 Eu 151.96	64 Gd 157.25	65 Tb 158.92	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
Actinide series	89 Ac (227)	90 Th 232.04	91 Pa (231)	92 U 238.03	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (249)	98 Cf (251)	99 Es (254)	100 Fm (253)	101 Md (256)	102 No (254)	103 Lw (257)

See Reference No. 13

THE ELECTROMAGNETIC SPECTRUM


GENERATOR 60 CYCLE
RADIO
TELEVISION
RADAR
TOASTER
VISIBLE LIGHT
ULTRA-VIOLET LAMP
MEDICAL DIAGNOSIS AND THERAPY
ELECTRIC WAVES
RADIO WAVES
INFRA-RED
ULTRA-VIOLET
X-RAYS
GAMMA-RAYS
PHOTON ENERGY (ev)
WAVELENGTH (cm)
FREQUENCY (cyc./sec.)
RED
ORANGE
YELLOW
GREEN
BLUE
VIOLET
WAVELENGTH
7.6 x 10⁻⁵cm
4 x 10⁻⁵cm

SELECTED COMMON ABBREVIATIONS

A°, A	Angstrom unit of length
abs.	absolute
amb.	ambient
app. mol. wt.	apparent molecular weight
atm.	atmospheric
at. wt.	atomic weight
b. p.	boiling point
bbl.	barrel
BTU	British thermal unit
cal.	calorie
cg.	centigram
cm.	centimeter
cgs system	centimeter-gram-second system
conc.	concentrated, concentration
cc, cm^3	cubic centimeter
cu. ft., ft^3	cubic foot
cfh	cubic feet per hour
cfm	cubic feet per minute
cfs	cubic feet per second
m^3, M^3	cubic meter
°	degree
°C	degree Centigrade, degree Celsius
°F	degree Fahrenheit
°K	degree Kelvin
°R	degree Reaumur, degree Rankine
ft.	foot
ft. lb.	foot pound
fpm	feet per minute
fps	feet per second
fps system	foot-pound-second system
f. p.	freezing point
gr.	grain
g, gm.	gram
hr.	hour
in.	inch
kcal.	kilocalorie
kg.	kilogram
km.	kilometer
liq.	liquid
l	liter
log	logarithm (common)
ln	logarithm (natural)
m. p.	melting point
m, M	meter
μ	micron
mks system	meter-kilogram-second system
mph	miles per hour
mg	milligram
ml	milliliter
mm	millimeter
mμ	millimicron
min.	minute
mol. wt.	molecular weight
oz.	ounce
ppb	parts per billion
pphm	parts per hundred million
ppm	parts per million
lb.	pound
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gage
r. p. m.	revolutions per minute
sec.	second
sp. gr.	specific gravity
sp. ht.	specific heat
sp. wt.	specific weight
sq.	square
scf	standard cubic foot
STP	standard temperature and pressure
temp.	temperature
wt.	weight

DIMENSI

Item	Symbol	Definition	Dimensions	Mass - Length - Time Metric cm - gm_m sec - °K	dy
acceleration	a		$\frac{\text{length}}{(\text{time})^2}$	$\frac{cm}{sec^2}$	
force	F		$\frac{(\text{mass})(\text{length})}{(\text{time})^2}$ force	$\frac{gm_m - cm}{sec^2}$	dyne
local acceleration due to gravity	g		$\frac{\text{length}}{(\text{time})^2}$	$\frac{cm}{sec^2}$	
dimensional constant	g_c		variable	(1) dimensionless	(1)
mass	m		mass $\frac{(\text{force})(\text{time})^2}{(\text{length})}$	gm_m	gm_m
density	ρ	$\frac{\text{mass}}{\text{volume}}$	$\frac{\text{mass}}{(\text{length})^3}$ $\frac{(\text{force})(\text{time})^2}{(\text{length})^4}$	$\frac{gm_m}{cm^3}$	$\frac{gm_m}{cm^3}$
universal gas constant	R	$\frac{(\text{force})(\text{length})}{(\text{mass-mole})(\text{temp})}$	$\frac{(\text{mass})(\text{length})^2}{(\text{time})^2(\text{mass-mole})(\text{temp})}$ $\frac{(\text{force})(\text{length})}{\left[\frac{(\text{force})(\text{time})^2}{(\text{length})} - \text{mole}\right](\text{temp})}$ $\frac{(\text{force})(\text{length})}{(\text{mass-mole})(\text{temp})}$	$\frac{8.31 \times 10^7 gm_m - cm^2}{sec^2 (gm_m - \text{mole})°K}$	8. (g
molecular weight	M	$\frac{\text{mass}}{(\text{mass - mole})}$	$\frac{\text{mass}}{(\text{mass - mole})}$ $\frac{(\text{force})(\text{time})^2}{\left[\frac{(\text{force})(\text{time})^2}{(\text{length})} - \text{mole}\right] \text{length}}$	$\frac{gm_m}{(gm_m - \text{mole})}$	$\frac{gm_m}{(gm_m - m}$
pressure	P	$\frac{\text{force}}{\text{area}}$	$\frac{\text{mass}}{(\text{length})(\text{time})^2}$ $\frac{\text{force}}{(\text{length})^2}$	$\frac{gm_m}{cm - sec^2}$	$\frac{dyne}{cm^2}$
weight	W	force due to gravity	$\frac{(\text{mass})(\text{length})}{(\text{time})^2}$ force	$\frac{gm_m - cm}{sec^2}$	dyne
specific weight	w	$\frac{\text{weight}}{\text{volume}}$	$\frac{\text{mass}}{(\text{length})^2(\text{time})^2}$ $\frac{\text{force}}{(\text{length})^3}$	$\frac{gm_m}{cm^2 - sec^2}$	$\frac{dyne}{cm^3}$
viscosity	μ	$\frac{\text{mass}}{(\text{length})(\text{time})}$	$\frac{\text{mass}}{(\text{length})(\text{time})}$ $\frac{(\text{force})(\text{time})}{(\text{length})^2}$	$\frac{gm_m}{cm - sec}$	$\frac{gm_m}{cm - se}$
kinematic viscosity	ν	$\frac{\text{viscosity}}{\text{density}}$	$\frac{(\text{length})^2}{\text{time}}$	$\frac{cm^2}{sec}$	
			Column Number	1	

A

DIMENSIONAL SYSTEMS AND SELECTED SYSTEMS OF UNITS OF MEASUREMENT

ABSOLUTE			**GRAVITATIONAL** Force - Length - Time		
Metric	English		Metric	English	
cm - gm_m dyne - sec - °K	ft - $\#_m$ - sec °R	ft - $\#_m$ - sec poundal - °R	cm - gm_f - sec - °K	ft - $\#_f$ sec - °R	ft - $\#_f$ - sec slug - °R
$\frac{cm}{sec^2}$	$\frac{ft}{sec^2}$	$\frac{ft}{sec^2}$	$\frac{cm}{sec^2}$	$\frac{ft}{sec^2}$	$\frac{ft}{sec^2}$
dyne	$\frac{\#_m - ft}{sec^2}$	poundal	gm_f	$\#_f$	$\#_f$
$\frac{cm}{sec^2}$	$\frac{ft}{sec^2}$	$\frac{ft}{sec^2}$	$\frac{cm}{sec^2}$	$\frac{ft}{sec^2}$	$\frac{ft}{sec^2}$
(1) $\frac{gm_m - cm}{dyne - sec^2}$	(1) dimensionless	(1) $\frac{\#_m - ft}{poundal - sec^2}$	(1) dimensionless	(1)dimensionless	(1) $\frac{slug - ft}{\#_f - sec^2}$
gm_m	$\#_m$	$\#_m$	$\frac{gm_f - sec^2}{cm}$	$\frac{\#_f - sec^2}{ft}$	slug
$\frac{gm_m}{cm^3}$	$\frac{\#_m}{ft^3}$	$\frac{\#_m}{ft^3}$	$\frac{gm_f - sec^2}{cm^4}$	$\frac{\#_f - sec^2}{ft^4}$	$\frac{slug}{ft^3}$
$\frac{8.31 \times 10^7\, dyne - cm}{(gm_m - mole) - °K}$	$\frac{4.97 \times 10^4\, \#_m - ft^2}{sec^2 (\#_m - mole)\, °R}$	$\frac{4.97 \times 10^4\, poundal - ft}{(\#_m - mole)\, °R}$	$\frac{8.31 \times 10^7\, gm_f - cm}{\left(\frac{gm_f - sec^2}{cm} - mole\right) °K}$	$\frac{4.97 \times 10^4\, \#_f - ft}{\left(\frac{\#_f - sec^2}{ft} - mole\right) °R}$	$\frac{4.97 \times 10^4\, \#_f - ft}{(slug - mole)\, °R}$
$\frac{gm_m}{(gm_m - mole)}$	$\frac{\#_m}{(\#_m - mole)}$	$\frac{\#_m}{(\#_m - mole)}$	$\frac{gm_f - sec^2}{cm\left(\frac{gm_f - sec^2}{cm} - mole\right)}$	$\frac{\#_f - sec^2}{\left(\frac{\#_f - sec^2}{ft} - mole\right) ft}$	$\frac{slug}{(slug - mole)}$
$\frac{dyne}{cm^2}$	$\frac{\#_m}{ft - sec^2}$	$\frac{poundal}{ft^2}$	$\frac{gm_f}{cm^2}$	$\frac{\#_f}{ft^2}$	$\frac{\#_f}{ft^2}$
dyne	$\frac{\#_m - ft}{sec^2}$	poundal	gm_f	$\#_f$	$\#_f$
$\frac{dyne}{cm^3}$	$\frac{\#_m}{ft^2 - sec^2}$	$\frac{poundal}{ft^3}$	$\frac{gm_f}{cm^3}$	$\frac{\#_f}{ft^3}$	$\frac{\#_f}{ft^3}$
$\frac{gm_m}{cm - sec}$	$\frac{\#_m}{ft - sec}$	$\frac{\#_m}{ft - sec}$	$\frac{gm_f - sec}{cm^2}$	$\frac{\#_f - sec}{ft^2}$	$\frac{\#_f - sec}{ft^2}$
$\frac{cm^2}{sec}$	$\frac{ft^2}{sec}$	$\frac{ft^2}{sec}$	$\frac{cm^2}{sec}$	$\frac{ft^2}{sec}$	$\frac{ft^2}{sec}$
2	3	4	5	6	7

B

F UNITS OF MEASUREMENT

GRAVITATIONAL Force - Length - Time			ENGINEERING Force- Mass - Length - Time		Dimensional System
Metric	English		Metric	English	Systems of Units of Measurement ←
cm - gm_f - sec - °K	ft - $\#_f$ sec - °R	ft - $\#_f$ - sec slug - °R	cm - gm_f gm_m sec - °K	ft - $\#_f$ - $\#_m$ sec - °R	
$\frac{cm}{sec^2}$	$\frac{ft}{sec^2}$	$\frac{ft}{sec^2}$	$\frac{cm}{sec^2}$	$\frac{ft}{sec^2}$	
gm_f	$\#_f$	$\#_f$	gm_f	$\#_f$	
$\frac{cm}{sec^2}$	$\frac{ft}{sec^2}$	$\frac{ft}{sec^2}$	$\frac{cm}{sec^2}$	$\frac{ft}{sec^2}$	
(1) dimensionless	(1)dimensionless	(1) $\frac{slug - ft}{\#_f - sec^2}$	981 $\frac{gm_m - cm}{gm_f - sec^2}$	$\frac{32.2\ \#_m - ft}{\#_f - sec^2}$	
$\frac{gm_f - sec^2}{cm}$	$\frac{\#_f - sec^2}{ft}$	slug	gm_m	$\#_m$	
$\frac{gm_f - sec^2}{cm^4}$	$\frac{\#_f - sec^2}{ft^4}$	$\frac{slug}{ft^3}$	$\frac{gm_m}{cm^3}$	$\frac{\#_m}{ft^3}$	
$\frac{8.31 \times 10^7 gm_f - cm}{\left(\frac{gm_f - sec^2}{cm} - mole\right) {}^\circ K}$	$\frac{4.97 \times 10^4 \#_f - ft}{\left(\frac{\#_f - sec^2}{ft} - mole\right) {}^\circ R}$	$\frac{4.97 \times 10^4 \#_f - ft}{(slug - mole)\ {}^\circ R}$	$\frac{8.47 \times 10^4\ gm_f - cm}{(gm_m - mole)\ {}^\circ K}$	$\frac{1544\ \#_f - ft}{(\#_m - mole) {}^\circ R}$	
$\frac{gm_f - sec^2}{cm\left(\frac{gm_f - sec^2}{cm} - mole\right)}$	$\frac{\#_f - sec^2}{\left(\frac{\#_f - sec^2}{ft} - mole\right) ft}$	$\frac{slug}{(slug - mole)}$	$\frac{gm_m}{(gm_m - mole)}$	$\frac{\#_m}{(\#_m - mole)}$	
$\frac{gm_f}{cm^2}$	$\frac{\#_f}{ft^2}$	$\frac{\#_f}{ft^2}$	$\frac{gm_f}{cm^2}$	$\frac{\#_f}{ft^2}$	
gm_f	$\#_f$	$\#_f$	gm_f	$\#_f$	
$\frac{gm_f}{cm^3}$	$\frac{\#_f}{ft^3}$	$\frac{\#_f}{ft^3}$	$\frac{gm_f}{cm^3}$	$\frac{\#_f}{ft^3}$	
$\frac{gm_f - sec}{cm^2}$	$\frac{\#_f - sec}{ft^2}$	$\frac{\#_f - sec}{ft^2}$	$\frac{gm_m}{cm - sec}$	$\frac{\#_m}{ft - sec}$	
$\frac{cm^2}{sec}$	$\frac{ft^2}{sec}$	$\frac{ft^2}{sec}$	$\frac{cm^2}{sec}$	$\frac{ft^2}{sec}$	
5	6	7	8	9	

C

DIMENSIONAL SYSTEMS AND SELECTED SYSTEMS OF UNITS OF MEASUREMENT

(continued)

TABLE 2. CONVERSION FACTORS FOR CONVERTING FORCE, MASS, LENGTH AND TIME BETWEEN THE ABSOLUTE AND GRAVITATIONAL DIMENSIONAL SYSTEMS

ABSOLUTE MASS - LENGTH - TIME				DIMENSIONAL SYSTEM ← DEFINED TERMS →	GRAVITATIONAL FORCE - LENGTH - TIME			
System of units of measurement	Item	Dimensions	Unit quantity	Conversion factors	Unit quantity	Dimensions	Item	System of units of measurement
cm - gm_m - sec ^oK (column no. 1)	Force	$\frac{(mass)\ (length)}{(time)^2}$	(1) $\frac{gm_m\text{-}cm}{sec^2}$	$980.665\ \frac{gm_m\text{-}cm}{sec^2} = 1.0197 \times 10^{-3}\ gm_f$	(1) gm_f	force	Force	cm - gm_f - sec ^oK (column no. 5)
	Mass	mass	(1) gm_m	$980.665\ gm_m = 1.0197 \times 10^{-3}\ \frac{gm_f\text{-}sec^2}{cm}$	(1) $\frac{gm_f\text{-}sec^2}{cm}$	$\frac{(force)\ (time)^2}{length}$	Mass	
	Length	length	(1) cm	(1) cm = (1) cm	(1) cm	length	Length	
	Time	time	(1) sec	(1) sec = (1) sec	(1) sec	time	Time	
cm - gm_m - dyne sec - ^oK (column no. 2)	Force	$\frac{(mass)\ (length)}{(time)^2}$	(1) dyne	$980.665\ dyne = 1.0197 \times 10^{-3}\ gm_f$	(1) gm_f	force	Force	
	Mass	mass	(1) gm_m	$980.665\ gm_m = 1.0197 \times 10^{-3}\ \frac{gm_f\text{-}sec^2}{cm}$	(1) $\frac{gm_f\text{-}sec^2}{cm}$	$\frac{(force)\ (time)^2}{length}$	Mass	
	Length	length	(1) cm	(1) cm = (1) cm	(1) cm	length	Length	
	Time	time	(1) sec	(1) sec = (1) sec	(1) sec	time	Time	
cm - gm_m - sec ^oK (column no. 1)	Force	$\frac{(mass)\ (length)}{(time)^2}$	(1) $\frac{gm_m\text{-}cm}{sec^2}$	$4.4482 \times 10^5\ \frac{gm_m\text{-}cm}{sec^2} = 2.2481 \times 10^{-6}\ \#_f$	(1) $\#_f$	force	Force	ft - $\#_f$ - sec ^oR (column no. 6)
	Mass	mass	(1) gm_m	$1.4594 \times 10^4\ gm_m = 6.8522 \times 10^{-5}\ \frac{\#_f - sec^2}{ft}$	(1) $\frac{\#_f - sec^2}{ft}$	$\frac{(force)\ (time)^2}{length}$	Mass	
	Length	length	(1) cm	30.48 cm = 3.2808×10^{-2} ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = (1) sec	(1) sec	time	Time	
cm - gm_m - dyne sec - ^oK (column no. 2)	Force	$\frac{(mass)\ (length)}{(time)^2}$	(1) dyne	$4.4482 \times 10^5\ dyne = 2.2481 \times 10^{-6}\ \#_f$	(1) $\#_f$	force	Force	
	Mass	mass	(1) gm_m	$1.4594 \times 10^4\ gm_m = 6.8522 \times 10^{-5}\ \frac{\#_f - sec^2}{ft}$	(1) $\frac{\#_f - sec^2}{ft}$	$\frac{(force)\ (time)^2}{length}$	Mass	
	Length	length	(1) cm	30.48 cm = 3.2808×10^{-2} ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = (1) sec	(1) sec	time	Time	

DIMENSIONAL SYSTEMS AND SELECTED SYSTEMS OF UNITS OF MEASUREMENT
(continued)

TABLE 2. CONVERSION FACTORS FOR CONVERTING FORCE, MASS, LENGTH AND TIME BETWEEN THE ABSOLUTE AND GRAVITATIONAL DIMENSIONAL SYSTEMS
(continued)

ABSOLUTE MASS - LENGTH - TIME				DIMENSIONAL SYSTEM ⟷ DEFINED TERMS	GRAVITATIONAL FORCE - LENGTH - TIME			
System of units of measurement	Item	Dimensions	Unit quantity	Conversion Factors	Unit quantity	Dimensions	Item	System of units of measurement
cm - gm_m - sec $^\circ K$ (column no. 1)	Force	$\frac{(mass)\ (length)}{(time)^2}$	$(1) \frac{gm_m - cm}{sec^2}$	$4.4482 \times 10^5 \frac{gm_m - cm}{sec^2}$ = $= 2.2481 \times 10^{-6}\ \#_f$	$(1)\ \#_f$	force	Force	ft - $\#_f$ - slug sec - $^\circ R$ (column no. 7)
	Mass	mass	$(1)\ gm_m$	$1.4594 \times 10^4\ gm_m$ = $= 6.8522 \times 10^{-5}$ slug	(1) slug	$\frac{(force)\ (time)^2}{length}$	Mass	
	Length	length	(1) cm	30.48 cm = $= 3.2808 \times 10^{-2}$ ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	
cm - gm_m - dyne sec - $^\circ K$ (column no. 2)	Force	$\frac{(mass)\ (length)}{(time)^2}$	(1) dyne	4.4482×10^5 dyne = $= 2.2481 \times 10^{-6}\ \#_f$	$(1)\ \#_f$	force	Force	
	Mass	mass	$(1)\ gm_m$	$1.4594 \times 10^4\ gm_m$ = $= 6.8522 \times 10^{-5}$ slug	(1) slug	$\frac{(force)\ (time)^2}{length}$	Mass	
	Length	length	(1) cm	30.48 cm = $= 3.2808 \times 10^{-2}$ ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	
ft - $\#_m$ - sec $^\circ R$ (column no. 3)	Force	$\frac{(mass)\ (length)}{(time)^2}$	$(1) \frac{\#_m - ft}{sec^2}$	$7.0932 \times 10^{-2} \frac{\#_m - ft}{sec^2}$ = $= 14.098\ gm_f$	$(1)\ gm_f$	force	Force	cm - gm_f - sec $^\circ K$ (column no. 5)
	Mass	mass	$(1)\ \#_m$	$2.1620\ \#_m$ = $= 0.46253 \frac{gm_f - sec^2}{cm}$	$(1) \frac{gm_f - sec^2}{cm}$	$\frac{(force)\ (time)^2}{length}$	Mass	
	Length	length	(1) ft	3.2808×10^{-2} ft = = 30.48 cm	(1) cm	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	
ft - $\#_m$ - poundal sec - $^\circ R$ (column no. 4)	Force	$\frac{(mass)\ (length)}{(time)^2}$	(1) poundal	7.0932×10^{-2} poundal = $= 14.098\ gm_f$	$(1)\ gm_f$	force	Force	
	Mass	mass	$(1)\ \#_m$	$2.1620\ \#_m$ = $= 0.46253 \frac{gm_f - sec^2}{cm}$	$(1) \frac{gm_f - sec^2}{cm}$	$\frac{(force)\ (time)^2}{length}$	Mass	
	Length	length	(1) ft	3.2808×10^{-2} ft = = 30.48 cm	(1) cm	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	

DIMENSIONAL SYSTEMS AND SELECTED SYSTEMS OF UNITS OF MEASUREMENT
(continued)

TABLE 2. CONVERSION FACTORS FOR CONVERTING FORCE, MASS, LENGTH AND TIME BETWEEN THE ABSOLUTE AND GRAVITATIONAL DIMENSIONAL SYSTEMS
(continued)

ABSOLUTE MASS - LENGTH - TIME				DIMENSIONAL SYSTEM ← DEFINED TERMS →	GRAVITATIONAL FORCE - LENGTH - TIME			
System of units of measurement	Item	Dimensions	Unit quantity	Conversion Factor	Unit quantity	Dimensions	Item	System of units of measurement
ft - $\#_m$ - sec $^{\circ}R$ (column no. 3)	Force	$\frac{(mass)\ (length)}{(time)^2}$	(1) $\frac{\#_m - ft}{sec^2}$	32.174 $\frac{\#_m - ft}{sec^2}$ = = 5.1081 × 10^{-2} $\#_f$	(1) $\#_f$	force	Force	ft - $\#_f$ - sec $^{\circ}R$ (column no. 6)
	Mass	mass	(1) $\#_m$	32.174 $\#_m$ = = 3.1081 × 10^{-2} $\frac{\#_f - sec^2}{ft}$	(1) $\frac{\#_f - sec^2}{ft}$	$\frac{(force)\ (time)^2}{length}$	Mass	
	Length	length	(1) ft	(1) ft = = (1) ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	
ft - $\#_m$ - poundal sec - $^{\circ}R$ (column no. 4)	Force	$\frac{(mass)\ (length)}{(time)^2}$	(1) poundal	32.174 poundal = = 3.1081 × 10^{-2} $\#_f$	(1) $\#_f$	force	Force	
	Mass	mass	(1) $\#_m$	32.174 $\#_m$ = = 3.1081 × 10^{-2} $\frac{\#_f - sec^2}{ft}$	(1) $\frac{\#_f - sec^3}{ft}$	$\frac{(force)\ (time)^2}{length}$	Mass	
	Length	length	(1) ft	(1) ft = = (1) ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	
ft - $\#_m$ - sec $^{\circ}R$ (column no. 3)	Force	$\frac{(mass)\ (length)}{(time)^2}$	(1) $\frac{\#_m - ft}{sec^3}$	32.174 $\frac{\#_m - ft}{sec^2}$ = = 3.1081 × 10^{-2} $\#_f$	(1) $\#_f$	force	Force	ft - $\#_f$ - slug sec - $^{\circ}R$ (column no. 7)
	Mass	mass	(1) $\#_m$	32.174 $\#_m$ = = 3.1081 × 10^{-2} slug	(1) slug	$\frac{(force)\ (time)^2}{length}$	Mass	
	Length	length	(1) ft	(1) ft = = (1) ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	
ft - $\#_m$ - poundal sec - $^{\circ}R$ (column no. 4)	Force	$\frac{(mass)\ (length)}{(time)^2}$	(1) poundal	32.174 poundal = = 3.1081 × 10^{-2} $\#_f$	(1) $\#_f$	force	Force	
	Mass	mass	(1) $\#_m$	32.174 $\#_m$ = = 3.1081 × 10^{-2} slug	(1) slug	$\frac{(force)\ (time)^2}{length}$	Mass	
	Length	length	(1) ft	(1) ft = = (1) ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	

DIMENSIONAL SYSTEMS AND SELECTED SYSTEMS OF UNITS OF MEASUREMENT
(continued)

TABLE 3. CONVERSION FACTORS FOR CONVERTING FORCE, MASS, LENGTH AND TIME BETWEEN THE ENGINEERING AND THE ABSOLUTE DIMENSIONAL SYSTEMS

ENGINEERING FORCE - MASS - LENGTH - TIME				DIMENSIONAL SYSTEM ← → DEFINED TERMS	ABSOLUTE MASS - LENGTH - TIME			
System of units of measurement	Item	Dimensions	Unit quantity	Conversion Factors	Unit quantity	Dimensions	Item	System of units of measurement
cm - gm$_f$ - gm$_m$ sec - °K (column no. 8)	Force	force	(1) gm$_f$	1.0197×10^{-3} gm$_f$ = = 980.665 $\frac{\text{gm}_m\text{-cm}}{\text{sec}^2}$	(1) $\frac{\text{gm}_m\text{-cm}}{\text{sec}^2}$	$\frac{\text{(mass) (length)}}{\text{(time)}^2}$	Force	cm - gm$_m$ - sec °K (column no. 1)
	Mass	mass	(1) gm$_m$	(1) gm$_m$ = = (1) gm$_m$	(1) gm$_m$	mass	Mass	
	Length	length	(1) cm	(1) cm = = (1) cm	(1) cm	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	
	Force	force	(1) gm$_f$	1.0197×10^{-3} gm$_f$ = = 980.665 dyne	(1) dyne	$\frac{\text{(mass) (length)}}{\text{(time)}^2}$	Force	cm - gm$_m$ - dyne sec - °K (column no. 2)
	Mass	mass	(1) gm$_m$	(1) gm$_m$ = = (1) gm$_m$	(1) gm$_m$	mass	Mass	
	Length	length	(1) cm	(1) cm = = (1) cm	(1) cm	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	
cm - gm$_f$ - gm$_m$ sec - °K (column no. 8)	Force	force	(1) gm$_f$	14.098 gm$_f$ = = 7.0932×10^{-2} $\frac{\#_m\text{ - ft}}{\text{sec}^2}$	(1) $\frac{\#_m\text{ - ft}}{\text{sec}^2}$	$\frac{\text{(mass) (length)}}{\text{(time)}^2}$	Force	ft - $\#_m$ - sec °R (column no. 3)
	Mass	mass	(1) gm$_m$	453.592 gm$_m$ = = 2.2046×10^{-3} $\#_m$	(1) $\#_m$	mass	Mass	
	Length	length	(1) cm	30.48 cm = = 3.2808×10^{-2} ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	
	Force	force	(1) gm$_f$	14.098 gm$_f$ = = 7.0932×10^{-2} poundal	(1) poundal	$\frac{\text{(mass) (length)}}{\text{(time)}^2}$	Force	ft - $\#_m$ - poundal sec - °R (column no. 4)
	Mass	mass	(1) gm$_m$	453.592 gm$_m$ = = 2.2046×10^{-3} ft	(1) $\#_m$	mass	Mass	
	Length	length	(1) cm	30.48 cm = = 3.2808×10^{-2} ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	

DIMENSIONAL SYSTEMS AND SELECTED SYSTEMS OF UNITS OF MEASUREMENT
(continued)

TABLE 3. CONVERSION FACTORS FOR CONVERTING FORCE, MASS, LENGTH AND TIME BETWEEN THE ENGINEERING AND THE ABSOLUTE DIMENSIONAL SYSTEMS
(continued)

ENGINEERING FORCE - MASS - LENGTH - TIME				DIMENSIONAL SYSTEM ← DEFINED TERMS →	ABSOLUTE MASS - LENGTH - TIME			
System of units of measurement	Item	Dimensions	Unit quantity	Conversion Factor	Unit quantity	Dimensions	Item	System of units of measurement
ft - $\#_f$ - $\#_m$ sec - $^\circ R$ (column no. 5)	Force	force	(1) $\#_f$	$2.2481 \times 10^{-6} \#_f$ = = $4.4482 \times 10^5 \frac{gm_m - cm}{sec^2}$	(1) $\frac{gm_m - cm}{sec^2}$	$\frac{(mass)\ (length)}{(time)^2}$	Force	cm - gm_m - sec $^\circ K$ (column no. 1)
	Mass	mass	(1) $\#_m$	$2.2046 \times 10^{-3} \#_m$ = = 453.592 gm_m	(1) gm_m	mass	Mass	
	Length	length	(1) ft	3.2808×10^{-2} ft = = 30.48 cm	(1) cm	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	
	Force	force	(1) $\#_f$	$2.2481 \times 10^{-6} \#_f$ = = 4.4482×10^5 dyne	(1) dyne	$\frac{(mass)\ (length)}{(time)^2}$	Force	cm - gm_m - dyne sec - $^\circ K$ (column no. 2)
	Mass	mass	(1) $\#_m$	$2.2046 \times 10^{-3} \#_m$ = = 453.592 gm_m	(1) gm_m	mass	Mass	
	Length	length	(1) ft	3.2808×10^{-2} ft = = 30.48 cm	(1) cm	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	
ft - $\#_f$ - $\#_m$ sec - $^\circ R$ (column no. 5)	Force	force	(1) $\#_f$	$3.1081 \times 10^{-2} \#_f$ = = $32.174 \frac{\#_m - ft}{sec^2}$	(1) $\frac{\#_m - ft}{sec^2}$	$\frac{(mass)\ (length)}{(time)^2}$	Force	ft - $\#_m$ - sec $^\circ R$ (column no. 3)
	Mass	mass	(1) $\#_m$	(1) $\#_m$ = = (1) $\#_m$	(1) $\#_m$	mass	Mass	
	Length	length	(1) ft	(1) ft = = (1) ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	
	Force	force	(1) $\#_f$	$3.1081 \times 10^{-2} \#_f$ = = 32.174 poundal	(1) poundal	$\frac{(mass)\ (length)}{(time)^2}$	Force	ft - $\#_m$ - poundal sec - $^\circ R$ (column no. 4)
	Mass	mass	(1) $\#_m$	(1) $\#_m$ = = (1) $\#_m$	(1) $\#_m$	mass	Mass	
	Length	length	(1) ft	(1) ft = = (1) ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	

DIMENSIONAL SYSTEMS AND SELECTED SYSTEMS OF UNITS OF MEASUREMENT
(continued)

TABLE 4. CONVERSION FACTORS FOR CONVERTING FORCE, MASS, LENGTH AND TIME BETWEEN THE ENGINEERING AND THE GRAVITATIONAL DIMENSIONAL SYSTEMS

ENGINEERING FORCE - MASS - LENGTH - TIME				DIMENSIONAL SYSTEM ⟵ ⟶ DEFINED TERMS	GRAVITATIONAL FORCE - LENGTH - TIME			
System of units of measurement	Item	Dimensions	Unit quantity	Conversion Factors	Unit quantity	Dimensions	Item	System of units of measurement
$cm - gm_f - gm_m$ $sec - {}^oK$ (column no. 8)	Force	force	(1) gm_f	(1) gm_f = = (1) gm_f	(1) gm_f	force	Force	$cm - gm_f - sec$ ${}^oK$ (column no. 5)
	Mass	mass	(1) gm_m	980.665 gm_m = = $1.0197 \times 10^{-3} \frac{gm_f - sec^2}{cm}$	(1) $\frac{gm_f - sec^2}{cm}$	$\frac{(force)(time)^2}{length}$	Mass	
	Length	length	(1) cm	(1) cm = = (1) cm	(1) cm	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	
$ft - \#_f - \#_m$ $sec - {}^oR$ (column no. 9)	Force	force	(1) $\#_f$	$2.2046 \times 10^{-3}\ \#_f$ = = 453.592 gm_f	(1) gm_f	force	Force	
	Mass	mass	(1) $\#_m$	2.1620 $\#_m$ = $0.46253 \frac{gm_f - sec^2}{cm}$	(1) $\frac{gm_f - sec^2}{cm}$	$\frac{(force)(time)^2}{length}$	Mass	
	Length	length	(1) ft	3.2808×10^{-2} ft = = 30.48 cm	(1) cm	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	
$cm - gm_f - gm_m$ $sec - {}^oK$ (column no. 8)	Force	force	(1) gm_f	453.592 gm_f = = $2.2046 \times 10^{-3}\ \#_f$	(1) $\#_f$	force	Force	$ft - \#_f - sec$ ${}^oR$ (column no. 6)
	Mass	mass	(1) gm_m	$1.4658 \times 10^4\ gm_m$ = = $6.8221 \times 10^{-5} \frac{\#_f - sec^2}{ft}$	(1) $\frac{\#_f - sec^2}{ft}$	$\frac{(force)\ (time)^2}{length}$	Mass	
	Length	length	(1) cm	30.48 cm = = 3.2808×10^{-2} ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	
$ft - \#_f - \#_m$ $sec - {}^oR$ (column no. 9)	Force	force	(1) $\#_f$	(1) $\#_f$ = = (1) $\#_f$	(1) $\#_f$	force	Force	
	Mass	mass	(1) $\#_m$	32.174 $\#_m$ = = $3.1081 \times 10^{-2} \frac{\#_f - sec^2}{ft}$	(1) $\frac{\#_f - sec^2}{ft}$	$\frac{(force)(time)^2}{length}$	Mass	
	Length	length	(1) ft	(1) ft = = (1) ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	

DIMENSIONAL SYSTEMS AND SELECTED SYSTEMS OF UNITS OF MEASUREMENT
(continued)

TABLE 4. CONVERSION FACTORS FOR CONVERTING FORCE, MASS, LENGTH AND TIME BETWEEN THE ENGINEERING AND THE GRAVITATIONAL DIMENSIONAL SYSTEMS
(continued)

ENGINEERING FORCE - MASS - LENGTH - TIME				DIMENSIONAL SYSTEM ← → DEFINED TERMS	GRAVITATIONAL FORCE - LENGTH - TIME			
System of units of measurement	Item	Dimensions	Unit quantity	Conversion Factor	Unit quantity	Dimensions	Item	System of units of measurement
cm - gm_f - gm_m sec - $^{\circ}K$ (column no. 8)	Force	force	(1) gm_f	453.592 gm_f = = 2.2046×10^{-3} $\#_f$	(1) $\#_f$	force	Force	ft - $\#_f$ - slug sec - $^{\circ}R$ (column no. 7)
	Mass	mass	(1) gm_m	1.4658×10^{4} gm_m = = 6.8221×10^{-5} slug	(1) slug	$\frac{(force)(time)^2}{length}$	Mass	
	Length	length	(1) cm	30.48 cm = = 3.2808×10^{-2} ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	
ft - $\#_f$ - $\#_m$ sec - $^{\circ}R$ (column no. 9)	Force	force	(1) $\#_f$	(1) $\#_f$ = = (1) $\#_f$	(1) $\#_f$	force	Force	
	Mass	mass	(1) $\#_m$	32.174 $\#_m$ = = 3.1081×10^{-2} slug	(1) slug	$\frac{(force)(time)^2}{length}$	Mass	
	Length	length	(1) ft	(1) ft = = (1) ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	

DIMENSIONAL SYSTEMS AND SELECTED SYSTEMS OF UNITS OF MEASUREMENT
(continued)

TABLE 5. CONVERSION FACTORS FOR CONVERTING FORCE, MASS, LENGTH, AND TIME WITHIN THE ABSOLUTE DIMENSIONAL SYSTEM

ABSOLUTE MASS - LENGTH - TIME				DIMENSIONAL SYSTEM ⟷ DEFINED TERMS	ABSOLUTE MASS - LENGTH - TIME			
System of units of measurement	Item	Dimensions	Unit quantity	Conversion Factors	Unit quantity	Dimensions	Item	System of units of measurement
cm - gm_m - sec $^\circ K$ (column no. 1)	Force	$\frac{(mass)(length)}{(time)^2}$	(1) $\frac{gm_m - cm}{sec^2}$	(1) $\frac{gm_m - cm}{sec^2}$ = 1 dyne	(1) dyne	$\frac{(mass)\ (length)}{(time)^2}$	Force	cm - gm_m - dyne sec - $^\circ K$ (column no. 2)
	Mass	mass	(1) gm_m	(1) gm_m = (1) gm_m	(1) gm_m	mass	Mass	
	Length	length	(1) cm	(1) cm = (1) cm	(1) cm	length	Length	
	Time	time	(1) sec	(1) sec = (1) sec	(1) sec	time	Time	
	Force	$\frac{(mass)(length)}{(time)^2}$	(1) $\frac{gm_m - cm}{sec^2}$	$1.3825 \times 10^4 \frac{gm_m - cm}{sec^2}$ = $7.2333 \times 10^{-5} \frac{\#_m - ft}{sec^2}$	(1) $\frac{\#_m - ft}{sec^2}$	$\frac{(mass)\ (length)}{(time)^2}$	Force	ft - $\#_m$ - sec $^\circ R$ (column no. 3)
	Mass	mass	(1) gm_m	453.592 gm_m = $2.2046 \times 10^{-3}\ \#_m$	(1) $\#_m$	mass	Mass	
	Length	length	(1) cm	30.48 cm = 3.2808×10^{-2} ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = (1) sec	(1) sec	time	Time	
cm - gm_m - dyne sec - $^\circ K$ (column no. 2)	Force	$\frac{(mass)(length)}{(time)^2}$	(1) dyne	1.3825×10^4 dyne = $7.2333 \times 10^{-5} \frac{\#_m - ft}{sec^2}$	(1) $\frac{\#_m - ft}{sec^2}$	$\frac{(mass)\ (length)}{(time)^2}$	Force	ft - $\#_m$ - sec $^\circ R$ (column no. 3)
	Mass	mass	(1) gm_m	453.592 gm_m = $2.2046 \times 10^{-3}\ \#_m$	(1) $\#_m$	mass	Mass	
	Length	length	(1) cm	30.48 cm = 3.2808×10^{-2} ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = (1) sec	(1) sec	time	Time	
	Force	$\frac{(mass)(length)}{(time)^2}$	(1) dyne	1.3825×10^4 dyne = 7.2333×10^{-5} poundal	(1) poundal	$\frac{(mass)\ (length)}{(time)^2}$	Force	ft - $\#_m$ - poundal sec - $^\circ R$ (column no. 4)
	Mass	mass	(1) gm_m	453.592 gm_m = $2.2046 \times 10^{-3}\ \#_m$	(1) $\#_m$	mass	Mass	
	Length	length	(1) cm	30.48 cm = 3.2808×10^{-2} ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = (1) sec	(1) sec	time	Time	

DIMENSIONAL SYSTEMS AND SELECTED SYSTEMS OF UNITS OF MEASUREMENT
(continued)

TABLE 5. CONVERSION FACTORS FOR CONVERTING FORCE, MASS, LENGTH, AND TIME WITHIN THE ABSOLUTE DIMENSIONAL SYSTEM
(continued)

ABSOLUTE MASS - LENGTH - TIME				DIMENSIONAL SYSTEM ← → DEFINED TERMS	ABSOLUTE MASS - LENGTH - TIME			
System of units of measurement	Item	Dimensions	Unit quantity	Conversion Factors	Unit quantity	Dimensions	Item	System of units of measurement
ft - $\#_m$ - poundal sec - $^{\circ}R$ (column no. 4)	Force	$\frac{(\text{mass})(\text{length})}{(\text{time})^2}$	(1) poundal	7.2333×10^{-5} poundal = = $1.3825 \times 10^{4}\ \frac{gm_m - cm}{sec^2}$	(1) $\frac{gm_m - cm}{sec^2}$	$\frac{(\text{mass})(\text{length})}{(\text{time})^2}$	Force	cm - gm_m - sec $^{\circ}K$ (column no. 1)
	Mass	mass	(1) $\#_m$	$2.2046 \times 10^{-3}\ \#_m$ = = 453.592 gm_m	(1) gm_m	mass	Mass	
	Length	length	(1) ft	3.2808×10^{-2} ft = = 30.48 cm	(1) cm	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	
	Force	$\frac{(\text{mass})(\text{length})}{(\text{time})^2}$	(1) poundal	(1) poundal = = (1) $\frac{\#_m - ft}{sec^2}$	(1) $\frac{\#_m - ft}{sec^2}$	$\frac{(\text{mass})(\text{length})}{(\text{time})^2}$	Force	ft - $\#_m$ - sec $^{\circ}R$ (column no. 3)
	Mass	mass	(1) $\#_m$	(1) $\#_m$ = = (1) $\#_m$	(1) $\#_m$	mass	Mass	
	Length	length	(1) ft	(1) ft = = (1) ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	

TABLE 6. CONVERSION FACTORS FOR CONVERTING FORCE, MASS, LENGTH AND TIME WITHIN THE ENGINEERING DIMENSIONAL SYSTEM

ENGINEERING FORCE - MASS - LENGTH - TIME				DIMENSIONAL SYSTEM ← → DEFINED TERMS	ENGINEERING FORCE - MASS - LENGTH - TIME			
System of units of measurement	Item	Dimensions	Unit quantity	Conversion Factor	Unit quantity	Dimensions	Item	System of units of measurement
cm - gm_f - gm_m sec - $^{\circ}K$ (column no. 8)	Force	force	(1) gm_f	453.592 gm_f = = $2.2046 \times 10^{-3}\ \#_f$	(1) $\#_f$	force	Force	ft - $\#_f$ - $\#_m$ sec - $^{\circ}R$ (column no. 9)
	Mass	mass	(1) gm_m	453.592 gm_m = = $2.2046 \times 10^{-3}\ \#_m$	(1) $\#_m$	mass	Mass	
	Length	length	(1) cm	30.48 cm = = 3.2808×10^{-2} ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	

DIMENSIONAL SYSTEMS AND SELECTED SYSTEMS OF UNITS OF MEASUREMENT
(continued)

TABLE 7. CONVERSION FACTORS FOR CONVERTING FORCE, MASS, LENGTH AND TIME WITHIN THE GRAVITATIONAL DIMENSIONAL SYSTEM

GRAVITATIONAL FORCE - LENGTH - TIME				DIMENSIONAL SYSTEM ←→ DEFINED TERMS	GRAVITATIONAL FORCE - LENGTH - TIME			
System of units of measurement	Item	Dimensions	Unit quantity	Conversion Factors	Unit quantity	Dimensions	Item	System of units of measurement
cm - gm_f - sec $^\circ K$ (column no. 5)	Force	force	(1) gm_f	453.592 gm_f = = 2.2046×10^{-3} $\#_f$	(1) $\#_f$	force	Force	ft - $\#_f$ - sec $^\circ R$ (column no. 6)
	Mass	$\frac{(force)\ (time)^2}{length}$	(1) $\frac{gm_f - sec^2}{cm}$	14.882 $\frac{gm_f - sec^2}{cm}$ = = 6.7197×10^{-2} $\frac{\#_f\text{-}sec^2}{ft}$	(1) $\frac{\#_f - sec^2}{ft}$	$\frac{(force)\ (time)^2}{length}$	Mass	
	Length	length	(1) cm	30.48 cm = = 3.2808×10^{-2} ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	
	Force	force	(1) gm_f	453.592 gm_f = = 2.2046×10^{-3} $\#_f$	(1) $\#_f$	force	Force	ft - $\#_f$ - slug sec - $^\circ R$ (column no. 7)
	Mass	$\frac{(force)\ (time)^2}{length}$	(1) $\frac{gm_f\text{-}sec^3}{cm}$	14.882 $\frac{gm_f\text{-}sec^2}{cm}$ = = 6.7197×10^{-2} slug	(1) slug	$\frac{(force)\ (time)^2}{length}$	Mass	
	Length	length	(1) cm	30.48 cm = = 3.2808×10^{-2} ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	
ft - $\#_f$ - sec $^\circ R$ (column no. 6)	Force	force	(1) $\#_f$	(1) $\#_f$ = = (1) $\#_f$	(1) $\#_f$	force	Force	ft - $\#_f$ - slug sec - $^\circ R$ (column no. 7)
	Mass	$\frac{(force)\ (time)^2}{length}$	(1) $\frac{\#_f - sec^2}{ft}$	(1) $\frac{\#_f - sec^2}{ft}$ = = (1) slug	(1) slug	$\frac{(force)\ (time)^2}{length}$	Mass	
	Length	length	(1) ft	(1) ft = = (1) ft	(1) ft	length	Length	
	Time	time	(1) sec	(1) sec = = (1) sec	(1) sec	time	Time	

SUMMARY OF SELECTED SYSTEMS OF UNITS OF MEASUREMENT WITHIN THE THREE BASIC DIMENSIONAL SYSTEMS

A summary of several systems of units of measurement is presented in Table 1. The three dimensional systems and the two basic systems of units of measurement are listed across the top of the table. Selected items for consideration are listed in the left column of the table. The dimensions for each of these items are given for each of the systems of measurement.

Notice that columns 1 and 2, columns 3 and 4, and columns 6 and 7 are separated by a dashed line. This is because the systems of units of measurement in these pairs of columns are essentially the same system of units of measurement. The only difference between the paired columns is that the term dyne (in column 2) is used to describe the unit force of 1 $\frac{gm_m - cm}{sec^2}$ in column 1, the term poundal (in column 4) is used to describe the unit force of 1 $\frac{\#_m - ft}{sec^2}$ in column 3; and the term slug (in column 7) is used to describe the unit mass of 1 $\frac{\#_f - sec^2}{ft}$ in column 6.

The systems of units of measurement in these paired columns are so similar that they are usually used interchangeably.

Notice that under the column entitled "Dimensions", some items have two different sets of dimensions which are separated by a slashed line. The two sets of dimensions are necessitated by the fact that in the absolute dimensional system, force is a secondary quantity while it is a primary quantity in the other two dimensional systems. In addition, mass is a secondary quantity in the gravitational dimensional system and a primary quantity in the other two dimensional systems. Notice also that as any of the items with two sets of dimensions is followed across the table through each of the systems of units of measurement, only one set of dimensions is given in each of the systems of units of measurement. Notice in the table proper that, if the dimensions of an item are in force units, the dimensions are placed above the slashed line and if the dimensions of the item are in mass units the dimensions are placed below the slashed line.

Notice that the universal gas constant (R) has three separate sets of dimensions one set for each of the three dimensional systems. This results from the fact that, by definition, the dimensions of the gas constant involve both force units and mass units. This means that, in the absolute dimensional system all dimensions are in mass units as illustrated by the first of the three sets of dimensions; in the gravitational dimensional system all dimensions are in force units as illustrated by the second of the three sets of dimensions; and in the engineering dimensional system the dimensions are in both force units and mass units as illustrated by the third set of dimensions.

Notice that the term mole in the dimensions of the universal gas constant and in the dimensions of molecular weight has an identifying tag labeling the mole as a mass-mole. Notice also that the dimensions of this tag changes from dimensional system to dimensional system and also from system of units of measurement to system of units of measurement. It is essential that this labeling tag change because the quantity of substance described by a mole of substance varies depending upon the dimensional system. To verify this last point one only has to look at the definition of a mole. A mole of any pure substance is that quantity of the substance whose mass is numerically equal to its molecular weight. This means that the quantity of a mole of substance will vary as the manner in which a unit of mass is defined.

DIMENSIONAL SYSTEMS AND SELECTED SYSTEMS OF UNITS OF MEASUREMENT
(continued)

CONVERSION FACTORS

With so many different dimensional systems and systems of units of measurement one must immediately ask how does one get from one system to another. Tables 2 through 7 provide conversion factors for converting any of the four basic quantities of force, mass, length, and time in one of the systems of units of measurement listed in Table 1 to any other system of units of measurement listed in Table 1. To provide a guide for the use of these tables each system of units of measurement in Table 1 has been given a column number. This column numbering has been carried throughout the tables.

The conversions for length are derived from a comparison of the primary standards of length in the Metric System of units of measurement and in the English System of units of measurement. Conversion factors for force and mass are derived in the following manner:

Example No. 1

Derive a conversion factor for converting

$$\frac{gm_m - cm}{sec^2} \text{ (force units in column No. 1)}$$

to an equivalent force unit of $\#_f$ (column No. 9). The following relationships are established from Newton's second law of mechanics (F = MA):

For Column No. 1:

$$1\ \frac{gm_m - cm}{sec^2} = 1\ gm_m \times 1\ \frac{cm}{sec^2}$$

For Column No. 9:

$$1\ \#_f = 1\ \#_m \times 32.174\ \frac{ft}{sec^2}$$

(To five significant figures)

Dividing these two relationships yields

$$\frac{1\ \dfrac{gm_m - cm}{sec^2}}{1\ \#_f} = \frac{1\ \dfrac{gm_m - cm}{sec^2}}{32.174\ \dfrac{\#_m - ft}{sec^2}}$$

It is known from a comparison of standards that 1 $\#_m$ is equivalent to 453.592 gm_m and that 1 ft. is equivalent to 30.48 cm. Substituting these equivalents into the above relationship yields:

$$\frac{1\ \dfrac{gm_m - cm}{sec^2}}{1\ \#_f} = \frac{1\ gm_m \times \dfrac{1\ \#_m}{453.592\ gm_m} \times \dfrac{cm}{sec^2} \times \dfrac{1\ ft}{30.48\ cm}}{32.174\ \dfrac{\#_m - ft}{sec^2}}$$

DIMENSIONAL SYSTEMS AND SELECTED SYSTEMS OF UNITS OF MEASUREMENT

(continued)

Cancelling like dimensions and rearranging terms yields:

$$1\,\frac{gm_m - cm}{sec^2} = \frac{1\ \#_f}{32.174 \times 453.592 \times 30.48}$$

$$1\,\frac{gm_m - cm}{sec^2} = 2.2481 \times 10^{-6}\ \#_f \quad \text{or}$$

$$1\ \#_f = 4.4482 \times 10^5\ \frac{gm_m - cm}{sec^2}$$

These two conversion factors are listed in Table 3.

Example No. 2

Derive a conversion factor for converting $\frac{gm_f - sec^2}{cm}$ (mass unit in column No. 5) to an equivalent mass unit of gm_m (column No. 8). The following relationships are established from Newton's second law of mechanics (F = MA):

For Column No. 5:

$$1\ gm_f = 1\,\frac{gm_f - sec^2}{cm} \times 1\,\frac{cm}{sec^2}$$

For Column No. 8:

$$1\ gm_f = 1\ gm_m \times 980.665\ \frac{cm}{sec^2}$$

Dividing these two relationships yields:

$$\frac{1\ gm_f}{1\ gm_f} = \frac{1\,\frac{gm_f - sec^2}{cm} \times \frac{cm}{sec^2}}{980.665\ gm_m \times \frac{cm}{sec^2}}$$

Cancelling like dimensions and rearranging terms yields:

$$1\,\frac{gm_f - sec^2}{cm} = 980.665\ gm_m \quad \text{or}$$

$$1\ gm_m = 1.0197 \times 10^{-3}\ \frac{gm_f - sec^2}{cm}$$

These two conversion factors are listed in Table 4.

The following examples will illustrate the use of these conversion factors:

Example No. 1

Convert a density of 1.0 $\frac{gm_m}{cm^3}$ (column No. 1) into an equivalent density in units of $\frac{\#_f - sec^2}{ft^4}$ (column No. 6). From Table 2 it can be seen that 1 gm_m is equivalent to $6.8522 \times 10^{-5}\ \frac{\#_f - sec^2}{ft}$ and 30.48 cm are equivalent to 1 ft. It follows that:

$$1.0\ \frac{gm_m}{cm^3} \times \frac{6.8522 \times 10^{-5}\ \frac{\#_f - sec^2}{ft}}{1\ gm_m} \times \left(\frac{30.48\ cm}{ft}\right)^3 \doteq 1.95\ \frac{\#_f - sec^2}{ft^4}$$

Therefore, a density of 1.0 $\frac{gm_m}{cm^3}$ is equivalent to a density of 1.95 $\frac{\#_f - sec^2}{ft^4}$

DIMENSIONAL SYSTEMS AND SELECTED SYSTEMS OF UNITS OF MEASUREMENT
(continued)

Example No. 2:

Convert a specific weight of 62.4 $\frac{\#_f}{ft^3}$ column No. 9) to an equivalent specific weight in units of $\frac{\#_m}{ft^2 - sec^2}$ (column No. 3). From Table 3 it can be seen that 1 $\#_f$ is equivalent to 32.174 $\frac{\#_m - ft}{sec^2}$.

It follows that:

$$62.4 \frac{\#_f}{ft^3} \times \frac{32.174 \frac{\#_m - ft}{sec^2}}{1 \ \#_f} = 2010 \frac{\#_m}{ft^2 - sec^2}$$

Therefore, a specific weight of 62.4 $\frac{\#_f}{ft^3}$ is equivalent to a specific weight of $2010 \frac{\#_m}{ft^2 - sec^2}$.

Example No. 3:

Prove that $\frac{4.97 \times 10^4 \ \#_m - ft^2}{sec^2 \left(\#_m - mole\right) {}^oR}$ (column No. 3) is equivalent to $\frac{8.47 \times 10^4 \ gm_f - cm}{(gm_m - mole) \ {}^oK}$ (column No. 8).

From Table 3 it can be seen that $1 \frac{\#_m - ft}{sec^2}$ is equivalent to 14.098 gm_f and that 1 ft. is equivalent to 30.48 cm. It follows that:

$$\frac{4.97 \times 10^4 \ \cancel{\#_m} - \cancel{ft^2}}{\cancel{sec^2} \left(\#_m - mole\right) {}^oR} \times \frac{14.098 \ gm_f}{\cancel{1} \frac{\cancel{\#_m} - \cancel{ft}}{\cancel{sec^2}}} \times \frac{30.48 \ cm}{\cancel{1 \ ft}}$$

From Table 3 and the discussion of mass - mole it can be seen that 1 (gm_m - mole) is equivalent to 2.2046×10^{-3} ($\#_m$ - mole). To get a ratio of °K to °R one only has to compare the total numbers of °K from absolute zero to the freezing point of water to the total number of °R from absolute zero to the freezing point of water. This ratio yields:

$$\frac{(460 + 32) \ {}^oR}{273 \ {}^oK} = \frac{1.8 \ {}^oR}{{}^oK}$$

Therefore, 1 °K is equivalent to 1.8 °R. It now follows that:

$$\frac{4.97 \times 10^4 \times 14.098 \ gm_f \times 30.48 \ cm}{(\cancel{\#_m - mole}) \ \cancel{{}^oR} \times \frac{1 \ (gm_m - mole)}{2.2046 \times 10^{-3} \ (\cancel{\#_m - mole})} \times \frac{1 \ {}^oK}{1.8 \ \cancel{{}^oR}}} =$$

$$4.97 \times 10^4 \times 14.098 \times 30.48 \times 2.2046 \times 10^{-3} \times \frac{1.8 \ gm_f - cm}{(gm_m - mole) \ {}^oK} =$$

$$\frac{8.47 \times 10^4 \ gm_f - cm}{(gm_m - mole) \ {}^oK} \text{ and is equivalent to } \frac{4.97 \times 10^4 \ \#_m - ft^2}{sec^2 \ (\#_m - mole) \ {}^oR}.$$

SECTION 2 TIME

Table of Equivalents of Time 2-1
Hours, Minutes and Seconds to Decimals of a Day 2-1
Decimals of a Day to Hours, Minutes, and Seconds 2-2
Minutes and Seconds to Decimals of an Hour 2-2

TABLE OF EQUIVALENTS OF TIME

1 mean solar second (sec., s.)
= 1.002738 sidereal seconds
1 mean solar minute (min., m.)
= 60 sec. (mean solar)
1 mean solar hour (hr., h.)
= 3600 sec. (mean solar)
= 60 min. (mean solar)
1 mean solar day (da., d.)
= 86400 sec. (mean solar)
= 1440 min. (mean solar)
= 24 hr. (mean solar)
= 24 hours 3 minutes 56.555 seconds of mean sidereal time
1 tropical (mean solar, ordinary) year (yr.)
= 31.5569×10^6 sec. (mean solar)
= 525949 min. (mean solar)
= 8765.81 hr. (mean solar)
= 365.2422 da. (mean solar)
= 366.2422 sidereal days
1 sidereal second
= 0.997270 sec. (mean solar)
1 sidereal day
= 86164.1 sec. (mean solar)
= 23 hr. 56 min. 4.091 sec. (mean solar)

HOURS, MINUTES AND SECONDS TO DECIMALS OF A DAY

Hours	Day	Min.	Day	Min.	Day	Sec.	Day	Sec.	Day
1	0.041 667	1	0.000 694	31	0.021 528	1	0.000 012	31	0.000 359
2	.083 333	2	.001 389	32	.022 222	2	.000 023	32	.000 370
3	.125 000	3	.002 083	33	.022 917	3	.000.035	33	.000 382
4	.166 667	4	.002 778	34	.023 611	4	.000 046	34	.000 394
5	0.208 333	5	0.003 472	35	0.024 305	5	0.000 058	35	0.000 405
6	.250 000	6	.004 167	36	.025 000	6	.000 069	36	.000 417
7	.291 667	7	.004 861	37	.025 694	7	.000 081	37	.000 428
8	.333 333	8	.005 556	38	.026 389	8	.000 093	38	.000 440
9	.375 000	9	.006 250	39	.027 083	9	.000 104	39	.000 451
10	0.416 667	10	0.006 944	40	0.027 778	10	0.000 116	40	0.000 463
11	.458 333	11	.007 639	41	.028 472	11	.000 127	41	.000 475
12	.500 000	12	.008 333	42	.029 167	12	.000 139	42	.000 486
13	.541 667	13	.009 028	43	.029 861	13	.000 150	43	.000 498
14	.583 333	14	.009 722	44	.030 556	14	.000 162	44	.000 509
15	0.625 000	15	0.010 417	45	0.031 250	15	0.000 174	45	0.000 521
16	.666 667	16	.011 111	46	.031 944	16	.000 185	46	.000 532
17	.708 333	17	.011 806	47	.032 639	17	.000 197	47	.000 544
18	.750 000	18	.012 500	48	.033 333	18	.000 208	48	.000 556
19	.791 667	19	.013 194	49	.034 028	19	.000 220	49	.000 567
20	0.833 333	20	0.013 889	50	0.034 722	20	0.000 231	50	0.000 579
21	.875 000	21	.014 583	51	.035 417	21	.000 243	51	.000 590
22	.916 667	22	.015 278	52	.036 111	22	.000 255	52	.000 602
23	.958 333	23	.015 972	53	.036 806	23	.000 266	53	.000 613
24	1.000 000	24	.016 667	54	.037 500	24	.000 278	54	.000 625
		25	0.017 361	55	0.038 194	25	0.000 289	55	0.000 637
		26	.018 056	56	.038 889	26	.000 301	56	.000 648
		27	.018 750	57	.039 583	27	.000 313	57	.000 660
		28	.019 444	58	.040 278	28	.000 324	58	.000 671
		29	.020 139	59	.040 972	29	.000 336	59	.000 683
		30	0.020 833	60	0.041 667	30	0.000 347	60	.000 694

See Reference No. 1

DECIMALS OF A DAY TO HOURS, MINUTES AND SECONDS

Days	Hr.	Min.	Sec.	Days	Min.	Sec.	Days	Sec.
0.01		14	24	0.0001		8.64	0.000001	0.09
.02		28	48	2		17.28	2	0.17
.03		43	12	3		25.92	3	0.26
.04		57	36	4		34.56	4	0.35
0.05	1	12	0	0.0005		43.20	0.000005	0.43
.06	1	26	24	6		51.84	6	0.52
.07	1	40	48	7	1	0.48	7	0.60
.08	1	55	12	8	1	9.12	8	0.69
.09	2	9	36	9	1	17.76	9	0.78
0.10	2	24	0	0.0010	1	26.40	0.000010	0.86
.20	4	48	0	20	2	52.80	20	1.73
.30	7	12	0	30	4	19.20	30	2.59
.40	9	36	0	40	5	45.60	40	3.46
0.50	12	0	0	0.0050	7	12.00	0.000050	4.32
.60	14	24	0	60	8	38.40	60	5.18
.70	16	48	0	70	10	4.80	70	6.05
.80	19	12	0	80	11	31.20	80	6.91
.90	21	36	0	90	12	57.60	90	7.78

MINUTES AND SECONDS TO DECIMALS OF AN HOUR

Min.	Decimals of an hour	Min.	Decimals of an hour	Sec.	Decimals of an hour	Sec.	Decimals of an hour
1	0.016 667	31	0.516 667	1	0.000 278	31	0.008 611
2	.033 333	32	.533 333	2	.000 556	32	.008 889
3	.050 000	33	.550 000	3	.000 833	33	.009 167
4	.066 667	34	.566 667	4	.001 111	34	.009 444
5	0.083 333	35	0.583 333	5	0.001 389	35	0.009 722
6	.100 000	36	.600 000	6	.001 667	36	.010 000
7	.116 667	37	.616 667	7	.001 944	37	.010 278
8	.133 333	38	.633 333	8	.002 222	38	.010 556
9	.150 000	39	.650 000	9	.002 500	39	.010 833
10	0.166 667	40	0.666 667	10	0.002 778	40	0.011 111
11	.183 333	41	.683 333	11	.003 056	41	.011 389
12	.200 000	42	.700 000	12	.003 333	42	.011 667
13	.216 667	43	.716 667	13	.003 611	43	.011 944
14	.233 333	44	.733 333	14	.003 889	44	.012 222
15	0.250 000	45	0.750 000	15	0.004 167	45	0.012 500
16	.266 667	46	.766 667	16	.004 444	46	.012 778
17	.283 333	47	.783 333	17	.004 722	47	.013 056
18	.300 000	48	.800 000	18	.005 000	48	.013 333
19	.316 667	49	.816 667	19	.005 278	49	.013 611
20	0.333 333	50	0.833 333	20	0.005 556	50	0.013 889
21	.350 000	51	.850 000	21	.005 833	51	.014 167
22	.366 667	52	.866 667	22	.006 111	52	.014 444
23	.383 333	53	.883 333	23	.006 389	53	.014 722
24	.400 000	54	.900 000	24	.006 667	54	.015 000
25	0.416 667	55	0.916 667	25	0.006 944	55	0.015 278
26	.433 333	56	.933 333	26	.007 222	56	.015 556
27	.450 000	57	.950 000	27	.007 500	57	.015 833
28	.466 667	58	.966 667	28	.007 778	58	.016 111
29	.483 333	59	.983 333	29	.008 056	59	.016 389
30	0.500 000	60	1.000 000	30	0.008 333	60	0.016 667

SECTION 3 TEMPERATURE

Temperature Equivalents Chart 3-1
Temperature Conversion Table, Centigrade-Fahrenheit 3-4
Temperature Equivalent Graph, Centigrade, Kelvin, Rankine, Fahrenheit .. 3-5

TEMPERATURE EQUIVALENTS CHART

°APPROXIMATE ABSOLUTE, °CENTIGRADE, °FAHRENHEIT, °REAUMUR

Scale	Symbol	Freezing point of water (1 atmos.)	Boiling point of water (1 atmos.)	Conversion formulae
Centigrade[*]	C.	0°	100°	$C=(5/9)(F-32)=(5/4)R=K-273.16=AA-273$
Fahrenheit	F.	32	212	$F=(9/5)C+32=(9/4)R+32=(9/5)(K-273.16)+32$
Reaumur	R.	0	80	$R=(4/9)(F-32)=(4/5)C=(4/5)(K-273.16)$
Thermodynamic Kelvin Absolute Centigrade	K., A.	273.16± 0.01[†]	373.16± 0.01[†]	$K=C+273.16=AA+0.16=(5/9)(F-32)+273.16$
Approximate Absolute	AA.	273	373	$AA=C+273=K-0.16=(5/9)(F-32)+273$
Rankine Absolute Fahrenheit	—	491.69	671.69	$\text{Rankine}=F+459.69$

PROPORTIONAL PARTS

C, K, AA	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
F	0.18	0.36	0.54	0.72	0.90	1.08	1.26	1.44	1.62
R	0.08	0.16	0.24	0.32	0.40	0.48	0.56	0.64	0.72
F	0.055+	0.111+	0.166+	0.222+	0.277+	0.333+	0.388+	0.444+	0.5
C, K, AA	0.044+	0.088+	0.133+	0.177+	0.222+	0.266+	0.311+	0.355+	0.4
R	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
R	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
C, K, AA	0.125	0.25	0.375	0.5	0.625	0.75	0.875	1.0	1.125
F	0.225	0.45	0.675	0.9	1.125	1.35	1.575	1.8	2.025

AA.	C.	F.	R.	AA.	C.	F.	R.	AA.	C.	F.	R.
375°	102°	215°6	81°6	350°	77°	170°6	61°6	325°	52°	125°6	41°6
374	101	213.8	80.8	349	76	168.8	60.8	324	51	123.8	40.8
373	100	212.0	80.0	348	75	167.0	60.0	323	50	122.0	40.0
372	99	210.2	79.2	347	74	165.2	59.2	322	49	120.2	39.2
371	98	208.4	78.4	346	73	163.4	58.4	321	48	118.4	38.4
370	97	206.6	77.6	345	72	161.6	57.6	320	47	116.6	37.6
369	96	204.8	76.8	344	71	159.8	56.8	319	46	114.8	36.8
368	95	203.0	76.0	343	70	158.0	56.0	318	45	113.0	36.0
367	94	201.2	75.2	342	69	156.2	55.2	317	44	111.2	35.2
366	93	199.4	74.4	341	68	154.4	54.4	316	43	109.4	34.4
365	92	197.6	73.6	340	67	152.6	53.6	315	42	107.6	33.6
364	91	195.8	72.8	339	66	150.8	52.8	314	41	105.8	32.8
363	90	194.0	72.0	338	65	149.0	52.0	313	40	104.0	32.0
362	89	192.2	71.2	337	64	147.2	51.2	312	39	102.2	31.2
361	88	190.4	70.4	336	63	145.4	50.4	311	38	100.4	30.4
360	87	188.6	69.6	335	62	143.6	49.6	310	37	98.6	29.6
359	86	186.8	68.8	334	61	141.8	48.8	309	36	96.8	28.8
358	85	185.0	68.0	333	60	140.0	48.0	308	35	95.0	28.0
357	84	183.2	67.2	332	59	138.2	47.2	307	34	93.2	27.2
356	83	181.4	66.4	331	58	136.4	46.4	306	33	91.4	26.4
355	82	179.6	65.6	330	57	134.6	45.6	305	32	89.6	25.6
354	81	177.8	64.8	329	56	132.8	44.8	304	31	87.8	24.8
353	80	176.0	64.0	328	55	131.0	44.0	303	30	86.0	24.0
352	79	174.2	63.2	327	54	129.2	43.2	302	29	84.2	23.2
351	78	172.4	62.4	326	53	127.4	42.4	301	28	82.4	22.4
350	77	170.6	61.6	325	52	125.6	41.6	300	27	80.6	21.6

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[*] The Ninth General Conference on Weights and Measures, October 1948, gave the degree of temperature the designation of *degree Celsius* in place of *degree centigrade*. See Stimson, H. F., The international temperature scale of 1948, Nat. Bur. Stand. Journ. Res., vol. 42, p. 209, 1949.

[†] R. T. Birge, Rev. Mod. Phys., vol. 13, p. 233, 1941.

See Reference No. 1

TEMPERATURE EQUIVALENTS CHART

°APPROXIMATE ABSOLUTE, °CENTIGRADE, °FAHRENHEIT, °REAUMUR

(continued)

AA.	C.	F.	R.	AA.	C.	F.	R.	AA.	C.	F.	R.
300°	27°	80°.6	21°.6	250°	—23°	—9°.4	—18°.4	200°	—73°	—99°.4	—58°.4
299	26	78.8	20.8	249	24	11.2	19.2	199	74	101.2	59.2
298	25	77.0	20.0	248	25	13.0	20.0	198	75	103.0	60.0
297	24	75.2	19.2	247	26	14.8	20.8	197	76	104.8	60.8
296	23	73.4	18.4	246	27	16.6	21.6	196	77	106.6	61.6
295	22	71.6	17.6	245	—28	—18.4	—22.4	195	—78	—108.4	—62.4
294	21	69.8	16.8	244	29	20.2	23.2	194	79	110.2	63.2
293	20	68.0	16.0	243	30	22.0	24.0	193	80	112.0	64.0
292	19	66.2	15.2	242	31	23.8	24.8	192	81	113.8	64.8
291	18	64.4	14.4	241	32	25.6	25.6	191	82	115.6	65.6
290	17	62.6	13.6	240	—33	—27.4	—26.4	190	—83	—117.4	—66.4
289	16	60.8	12.8	239	34	29.2	27.2	189	84	119.2	67.2
288	15	59.0	12.0	238	35	31.0	28.0	188	85	121.0	68.0
287	14	57.2	11.2	237	36	32.8	28.8	187	86	122.8	68.8
286	13	55.4	10.4	236	37	34.6	29.6	186	87	124.6	69.6
285	12	53.6	9.6	235	—38	—36.4	—30.4	185	—88	—126.4	—70.4
284	11	51.8	8.8	234	39	38.2	31.2	184	89	128.2	71.2
283	10	50.0	8.0	233	40	40.0	32.0	183	90	130.0	72.0
282	9	48.2	7.2	232	41	41.8	32.8	182	91	131.8	72.8
281	8	46.4	6.4	231	42	43.6	33.6	181	92	133.6	73.6
280	7	44.6	5.6	230	—43	—45.4	—34.4	180	—93	—135.4	—74.4
279	6	42.8	4.8	229	44	47.2	35.2	179	94	137.2	75.2
278	5	41.0	4.0	228	45	49.0	36.0	178	95	139.0	76.0
277	4	39.2	3.2	227	46	50.8	36.8	177	96	140.8	76.8
276	3	37.4	2.4	226	47	52.6	37.6	176	97	142.6	77.6
275	+2	35.6	+1.6	225	—48	—54.4	—38.4	175	—98	—144.4	—78.4
274	+1	33.8	+0.8	224	49	56.2	39.2	174	99	146.2	79.2
273	0	32.0	0.0	223	50	58.0	40.0	173	100	148.0	80.0
272	—1	30.2	—0.8	222	51	59.8	40.8	172	101	149.8	80.8
271	—2	28.4	—1.6	221	52	61.6	41.6	171	102	151.6	81.6
270	—3	26.6	—2.4	220	—53	—63.4	—42.4	170	—103	—153.4	—82.4
269	4	24.8	3.2	219	54	65.2	43.2	169	104	155.2	83.2
268	5	23.0	4.0	218	55	67.0	44.0	168	105	157.0	84.0
267	6	21.2	4.8	217	56	68.8	44.8	167	106	158.8	84.8
266	7	19.4	5.6	216	57	70.6	45.6	166	107	160.6	85.6
265	—8	17.6	—6.4	215	—58	—72.4	—46.4	165	—108	—162.4	—86.4
264	9	15.8	7.2	214	59	74.2	47.2	164	109	164.2	87.2
263	10	14.0	8.0	213	60	76.0	48.0	163	110	166.0	88.0
262	11	12.2	8.8	212	61	77.8	48.8	162	111	167.8	88.8
261	12	10.4	9.6	211	62	79.6	49.6	161	112	169.6	89.6
260	—13	8.6	—10.4	210	—63	—81.4	—50.4	160	—113	—171.4	—90.4
259	14	6.8	11.2	209	64	83.2	51.2	159	114	173.2	91.2
258	15	5.0	12.0	208	65	85.0	52.0	158	115	175.0	92.0
257	16	3.2	12.8	207	66	86.8	52.8	157	116	176.8	92.8
256	17	+1.4	13.6	206	67	88.6	53.6	156	117	178.6	93.6
255	—18	—0.4	—14.4	205	—68	—90.4	—54.4	155	—118	—180.4	—94.4
254	19	2.2	15.2	204	69	92.2	55.2	154	119	182.2	95.2
253	20	4.0	16.0	203	70	94.0	56.0	153	120	184.0	96.0
252	21	5.8	16.8	202	71	95.8	56.8	152	121	185.8	96.8
251	22	7.6	17.6	201	72	97.6	57.6	151	122	187.6	97.6
250	—23	—9.4	—18.4	200	—73	—99.4	—58.4	150	—123	—189.4	—98.4

TEMPERATURE EQUIVALENTS CHART

°APPROXIMATE ABSOLUTE, °CENTIGRADE, ° FAHRENHEIT, ° REAUMUR

(continued)

AA.	C.	F.	R.	AA.	C.	F.	R.	AA.	C.	F.	R.
150°	−123°	−189°4	− 98°4	100°	−173°	−279°4	−138°4	50°	−223°	−369°4	−178°4
149	124	191.2	99.2	99	174	281.2	139.2	49	224	371.2	179.2
148	125	193.0	100.0	98	175	283.0	140.0	48	225	373.0	180.0
147	126	194.8	100.8	97	176	284.8	140.8	47	226	374.8	180.8
146	127	196.6	101.6	96	177	286.6	141.6	46	227	376.6	181.6
145	−128	−198.4	−102.4	95	−178	−288.4	−142.4	45	−228	−378.4	−182.4
144	129	200.2	103.2	94	179	290.2	143.2	44	229	380.2	183.2
143	130	202.0	104.0	93	180	292.0	144.0	43	230	382.0	184.0
142	131	203.8	104.8	92	181	293.8	144.8	42	231	383.8	184.8
141	132	205.6	105.6	91	182	295.6	145.6	41	232	385.6	185.6
140	−133	−207.4	−106.4	90	−183	−297.4	−146.4	40	−233	−387.4	−186.4
139	134	209.2	107.2	89	184	299.2	147.2	39	234	389.2	187.2
138	135	211.0	108.0	88	185	301.0	148.0	38	235	391.0	188.0
137	136	212.8	108.8	87	186	302.8	148.8	37	236	392.8	188.8
136	137	214.6	109.6	86	187	304.6	149.6	36	237	394.6	189.6
135	−138	−216.4	−110.4	85	−188	−306.4	−150.4	35	−238	−396.4	−190.4
134	139	218.2	111.2	84	189	308.2	151.2	34	239	398.2	191.2
133	140	220.0	112.0	83	190	310.0	152.0	33	240	400.0	192.0
132	141	221.8	112.8	82	191	311.8	152.8	32	241	401.8	192.8
131	142	223.6	113.6	81	192	313.6	153.6	31	242	403.6	193.6
130	−143	−225.4	−114.4	80	−193	−315.4	−154.4	30	−243	−405.4	−194.4
129	144	227.2	115.2	79	194	317.2	155.2	29	244	407.2	195.2
128	145	229.0	116.0	78	195	319.0	156.0	28	245	409.0	196.0
127	146	230.8	116.8	77	196	320.8	156.8	27	246	410.8	196.8
126	147	232.6	117.6	76	197	322.6	157.6	26	247	412.6	197.6
125	−148	−234.4	−118.4	75	−198	−324.4	−158.4	25	−248	−414.4	−198.4
124	149	236.2	119.2	74	199	326.2	159.2	24	249	416.2	199.2
123	150	238.0	120.0	73	200	328.0	160.0	23	250	418.0	200.0
122	151	239.8	120.8	72	201	329.8	160.8	22	251	419.8	200.8
121	152	241.6	121.6	71	202	331.6	161.6	21	252	421.6	201.6
120	−153	−243.4	−122.4	70	−203	−333.4	−162.4	20	−253	−423.4	−202.4
119	154	245.2	123.2	69	204	335.2	163.2	19	254	425.2	203.2
118	155	247.0	124.0	68	205	337.0	164.0	18	255	427.0	204.0
117	156	248.8	124.8	67	206	338.8	164.8	17	256	428.8	204.8
116	157	250.6	125.6	66	207	340.6	165.6	16	257	430.6	205.6
115	−158	−252.4	−126.4	65	−208	−342.4	−166.4	15	−258	−432.4	−206.4
114	159	254.2	127.2	64	209	344.2	167.2	14	259	434.2	207.2
113	160	256.0	128.0	63	210	346.0	168.0	13	260	436.0	208.0
112	161	257.8	128.8	62	211	347.8	168.8	12	261	437.8	208.8
111	162	259.6	129.6	61	212	349.6	169.6	11	262	439.6	209.6
110	−163	−261.4	−130.4	60	−213	−351.4	−170.4	10	−263	−441.4	−210.4
109	164	263.2	131.2	59	214	353.2	171.2	9	264	443.2	211.2
108	165	265.0	132.0	58	215	355.0	172.0	8	265	445.0	212.0
107	166	266.8	132.8	57	216	356.8	172.8	7	266	446.8	212.8
106	167	268.6	133.6	56	217	358.6	173.6	6	267	448.6	213.6
105	−168	−270.4	−134.4	55	−218	−360.4	−174.4	5	−268	−450.4	−214.4
104	169	272.2	135.2	54	219	362.2	175.2	4	269	452.2	215.2
103	170	274.0	136.0	53	220	364.0	176.0	3	270	454.0	216.0
102	171	275.8	136.8	52	221	365.8	176.8	2	271	455.8	216.8
101	172	277.6	137.6	51	222	367.6	177.6	1	272	457.6	217.6
100	−173	−279.4	−138.4	50	−223	−369.4	−178.4	0	−273	−459.4	−218.4

TEMPERATURE CONVERSION TABLE
CENTIGRADE – FAHRENHEIT

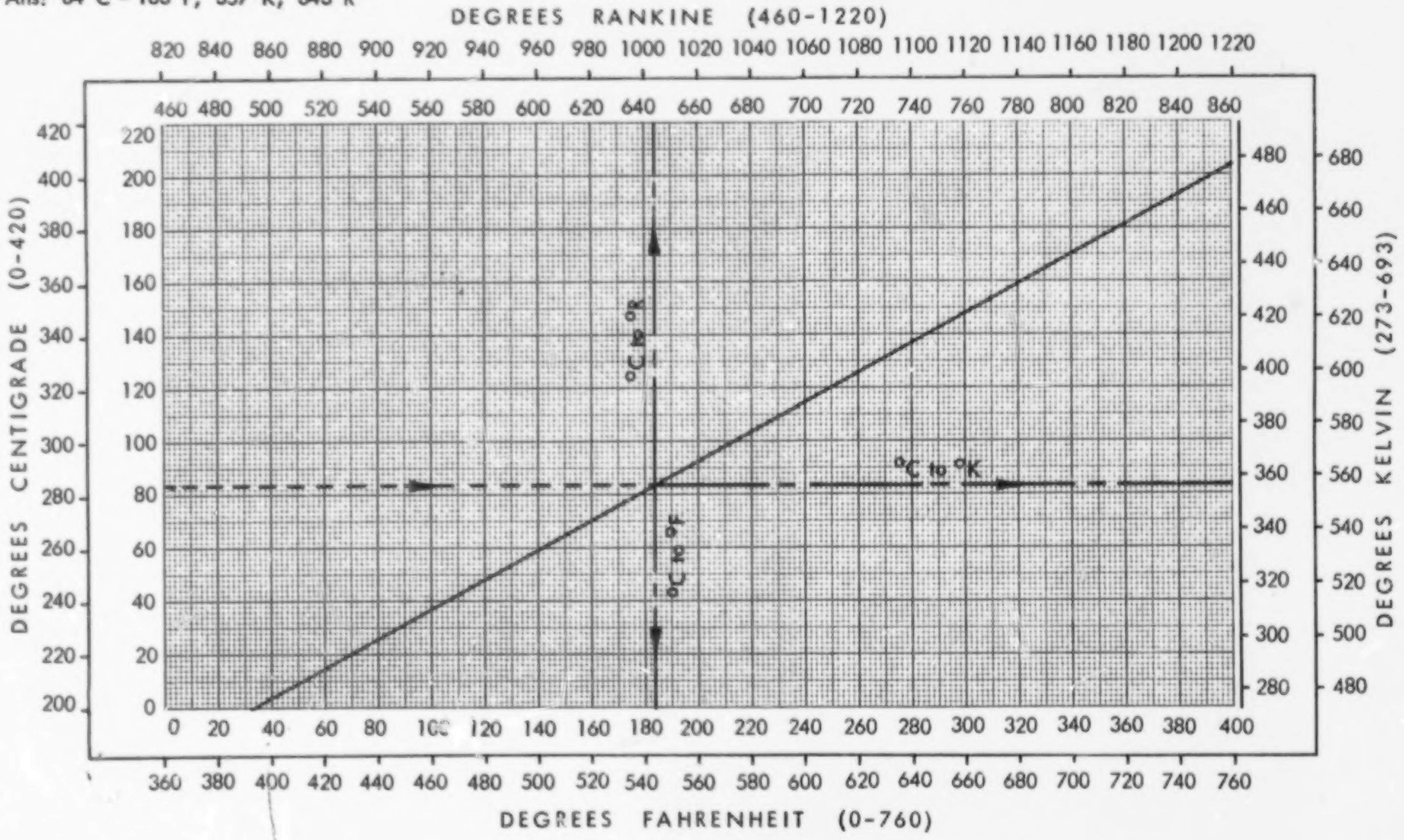
The numbers in the second column of each section refer to the temperature either in degrees Centigrade or Fahrenheit which it is desired to convert. If converting from Fahrenheit degrees to Centigrade degrees the equivalent temperature will be found in the left column, while if converting from degrees Centigrade to degrees Fahrenheit, the answer will be found in the column on the right. These Albert Sauveur temperature conversion tables are reproduced through the courtesy of University Press, Inc.

-60° to +59°			60° to 330°			340° to 990°			1000° to 1600°			1670° to 2330°			2340° to 3000°		
C		F	C		F	C		F	C		F	C		F	C		F
-51	-60	-76	15.6	60	140.0	171	340	644	538	1000	1832	909	1670	3038	1281	2340	4244
-46	-50	-58	16.1	61	141.8	177	350	662	543	1010	1850	915	1680	3056	1286	2350	4262
-40	-40	-40	16.6	62	143.6	182	360	680	549	1020	1868	920	1690	3074	1292	2360	4280
-34	-30	-22	17.1	63	145.4	188	370	698	554	1030	1886	926	1700	3092	1297	2370	4298
-29	-20	-4	17.7	64	147.2	193	380	716	560	1040	1904	931	1710	3110	1303	2380	4316
-23	-10	14	18.2	65	149.0	199	390	734	565	1050	1922	937	1720	3128	1308	2390	4334
-17.7	0	32	18.8	66	150.8	204	400	752	571	1060	1940	942	1730	3146	1315	2400	4352
-17.2	1	33.8	19.3	67	152.6	210	410	770	576	1070	1958	948	1740	3164	1320	2410	4370
-16.6	2	35.6	19.9	68	154,4	215	420	788	582	1080	1976	953	1750	3182	1326	2420	4388
-16.1	3	37.4	20.4	69	156.2	221	430	806	587	1090	1994	959	1760	3200	1331	2430	4006
-15.5	4	39.2	21.0	70	158.0	226	440	824	593	1100	2012	964	1770	3218	1337	2440	4424
-15.0	5	41.0	21.5	71	159.8	232	450	842	598	1110	2030	970	1780	3236	1342	2450	4442
-14.4	6	42.8	22.2	72	161.6	238	460	860	604	1120	2048	975	1790	3254	1348	2460	4460
-13.9	7	44.6	22.7	73	163.4	243	470	878	609	1130	2066	981	1800	3272	1353	2470	4478
-13.3	8	46.4	23.3	74	165.2	249	480	896	615	1140	2084	986	1810	3290	1359	2480	4496
-12.7	9	48.2	23.8	75	167.0	254	490	914	620	1150	2102	992	1820	3308	1364	2490	4514
-12.2	10	50.0	24.4	76	168.8	260	500	932	626	1160	2120	997	1830	3326	1371	2500	4532
-11.6	11	51.8	25.0	77	170.6	265	510	950	631	1170	2138	1003	1840	3344	1376	2510	4550
-11.1	12	53.6	25.5	78	172.4	271	520	968	637	1180	2156	1008	1850	3362	1382	2520	4568
-10.5	13	55.4	26.2	79	174.2	276	530	986	642	1190	2174	1014	1860	3380	1387	2530	4586
-10.0	14	57.2	26.8	80	176.0	282	540	1004	648	1200	2192	1019	1870	3398	1393	2540	4604
-9.4	15	59.0	27.3	81	177.8	288	550	1022	653	1210	2210	1025	1880	3416	1398	2550	4622
-8.8	16	60.8	27.7	82	179.6	293	560	1040	659	1220	2228	1030	1890	3434	1404	2560	4640
-8.3	17	62.6	28.2	83	181.4	299	570	1058	664	1230	2246	1036	1900	3452	1409	2570	4658
-7.7	18	64.4	28.8	84	183.2	304	580	1076	670	1240	2264	1041	1910	3470	1415	2580	4676
-7.2	19	66.2	29.3	85	185.0	310	590	1094	675	1250	2282	1047	1920	3488	1420	2590	4694
-6.6	20	68.0	29.9	86	186.8	315	600	1112	681	1260	2300	1052	1930	3506	1427	2600	4712
-6.1	21	69.8	30.4	87	188.6	321	610	1130	686	1270	2318	1058	1940	3524	1432	2610	4730
-5.5	22	71.6	31.0	88	190.4	326	620	1148	692	1280	2336	1063	1950	3542	1438	2620	4748
-5.0	23	73.4	31.5	89	192.2	332	630	1166	697	1290	2354	1069	1960	3560	1443	2630	4766
-4.4	24	75.2	32.1	90	194.0	338	640	1184	704	1300	2372	1074	1970	3578	1449	2640	4784
-3.9	25	77.0	32.6	91	195.8	343	650	1202	708	1310	2390	1080	1980	3596	1454	2650	4802
-3.3	26	78.8	33.3	92	197.6	349	660	1220	715	1320	2408	1085	1990	3614	1460	2660	4820
-2.8	27	80.6	33.8	93	199.4	354	670	1238	719	1330	2426	1093	2000	3632	1465	2670	4838
-2.2	28	82.4	34.4	94	201.2	360	680	1256	726	1340	2444	1098	2010	3650	1471	2680	4856
-1.6	29	84.2	34.9	95	203.0	365	690	1274	734	1350	2462	1104	2020	3668	1476	2690	4874
-1.1	30	86.0	35.5	96	204.8	371	700	1292	737	1360	2480	1109	2030	3686	1483	2700	4892
-.6	31	87.8	36.1	97	206.6	376	710	1310	741	1370	2498	1115	2040	3704	1488	2710	4910
0	32	89.6	36.6	98	208.4	382	720	1328	748	1380	2516	1120	2050	3722	1494	2720	4928
.5	33	91.4	37.1	99	210.2	387	730	1346	752	1390	2534	1126	2060	3740	1499	2730	4946
1.1	34	93.2	37.7	100	212.0	393	740	1364	760	1400	2552	1131	2070	3758	1505	2740	4964
1.6	35	95.0	38	100	212	399	750	1382	765	1410	2570	1137	2080	3776	1510	2750	4982
2.2	36	96.8	43	110	230	404	760	1400	771	1420	2588	1142	2090	3794	1516	2760	5000
2.7	37	98.6	49	120	248	410	770	1418	776	1430	2606	1149	2100	3812	1521	2770	5018
3.3	38	100.4	54	130	266	415	780	1436	782	1440	2624	1154	2110	3830	1527	2780	5036
3.8	39	102.2	60	140	284	421	790	1454	787	1450	2642	1160	2120	3848	1532	2790	5054
4.4	40	104.0	65	150	302	426	800	1472	793	1460	2660	1165	2130	3866	1538	2800	5072
4.9	41	105.8	71	160	320	432	810	1490	798	1470	2678	1171	2140	3884	1543	2810	5090
5.5	42	107.6	76	170	338	438	820	1508	804	1480	2696	1176	2150	3902	1549	2820	5108
6.0	43	109.4	83	180	356	443	830	1526	809	1490	2714	1182	2160	3920	1554	2830	5126
6.6	44	111.2	88	190	374	449	840	1544	815	1500	2732	1187	2170	3938	1560	2840	5144
7.1	45	113.0	93	200	392	454	850	1562	820	1510	2750	1193	2180	3956	1565	2850	5162
7.7	46	114.8	99	210	410	460	860	1580	827	1520	2768	1198	2190	3974	1571	2860	5180
8.2	47	116.6	100	212	413	465	870	1598	831	1530	2786	1204	2200	3992	1576	2870	5198
8.8	48	118.4	104	220	428	471	880	1616	838	1540	2804	1209	2210	4010	1582	2880	5216
9.3	49	120.2	110	230	446	476	890	1634	842	1550	2822	1215	2220	4028	1587	2890	5234
9.9	50	122.0	115	240	464	482	900	1652	849	1560	2840	1220	2230	4046	1593	2900	5252
10.4	51	123.8	121	250	482	487	910	1670	853	1570	2858	1226	2240	4064	1598	2910	5270
11.1	52	125.6	127	260	500	493	920	1688	860	1580	2876	1231	2250	4082	1604	2920	5288
11.5	53	127.4	132	270	518	498	930	1706	864	1590	2894	1237	2260	4100	1609	2930	5306
12.1	54	129.2	138	280	536	504	940	1724	871	1600	2912	1242	2270	4118	1615	2940	5324
12.6	55	131.0	143	290	554	510	950	1742	876	1610	2930	1248	2280	4136	1620	2950	5342
13.2	56	132.8	149	300	572	515	960	1760	882	1620	2948	1253	2290	4154	1626	2960	5360
13.7	57	134.6	154	310	590	520	970	1778	887	1630	2966	1259	2300	4172	1631	2970	5378
14.3	58	136.4	160	320	608	526	980	1796	893	1640	2984	1264	2310	4190	1637	2980	5396
14.8	59	138.2	165	330	626	532	990	1814	898	1650	3002	1270	2320	4208	1642	2990	5414
									904	1660	3020	1275	2330	4226	1649	3000	5432

See Reference No. 2

TEMPERATURE EQUIVALENT GRAPH CENTIGRADE, KELVIN, RANKINE, FAHRENHEIT

Example:
Convert 84°C to °F, °K, °R
Ans: 84°C = 183°F, 357°K, 643°R



SECTION 4 LENGTHS

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Decimals of an Inch for Each 64th of an Inch with Millimeter Equivalents .. 4-3
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TABLE OF EQUIVALENTS

When the name of a unit is enclosed in brackets (thus, [1 hand] ----), this indicates (1) that the unit is not in general current use in the United States, or (2) that the unit is believed to be based on "custom and usage" rather than on formal authoritative definition.

Equivalents involving decimals are, in most instances, rounded off to the third decimal place except where they are exact, in which cases these exact equivalents are so designated.

LENGTHS

1 angstrom (A)[a]	0.1 millimicron. 0.000 1 micron. 0.000 000 1 millimeter. 0.000 000 004 inch.
1 cable's length	120 fathoms. 720 feet. 219.456 meters.
1 centimeter (cm)	0.393 7 inch (exactly).
1 chain (ch) (Gunter's or surveyors)	66 feet. 20.117 meters.
[1 chain] (engineers)	100 feet. 30.480 meters.
1 decimeter (dm)	3.937 inches (exactly).
1 dekameter (dkm)	32.808 feet.
1 fathom	6 feet. 1.829 meters.
1 foot (ft)	0.305 meter.
1 furlong (fur.)	10 chains (surveyors). 660 feet. 220 yards. 1/8 statute mile. 201.168 meters.
[1 hand]	4 inches.
1 inch (in.)	2.540 centimeters.
1 kilometer (km)	0.621 mile.
1 league (land)	3 statute miles. 4.828 kilometers.
1 link (li) (Gunter's or surveyors)	7.92 inches (exactly). 0.201 meter.
[1 link (li) (engineers)]	1 foot. 0.305 meter.
1 meter (m)	39.37 inches (exactly). 1.094 yards.
1 micron (μ [the Greek letter mu])	0.001 millimeter (exactly). 0.000 039 37 inch (exactly).
1 mil	0.001 inch (exactly). 0.025 4 millimeter.
1 mile (mi) (statute or land)	5 280 feet. 1.609 kilometers.
[1 mile (mi) (nautical, geographical, or sea, U. S.)][b]	1.152 statute miles. 6 080.20 feet. 1.853 kilometers. 1.001 international nautical mile.
1 mile (mi) (nautical, international)[b]	1.852 kilometers (exactly). 1.151 statute miles. 0.999 U. S. nautical miles.
1 millimeter (mm)	0.039 37 inch (exactly).
1 millimicron (mμ [the English letter m in combination with the Greek letter mu])	0.001 micron (exactly). 0.000 000 039 37 inch (exactly).
1 point (typography)	0.013 837 inch (exactly). 1/72 inch (approximately). 0.351 millimeter.
1 rod (rd), pole, or perch	16½ feet. 5½ yards. 5.029 meters.
1 yard (yd)	0.914 meter.

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[a] The angstrom is basically defined in terms of the wavelength of the red radiation of cadmium under specified conditions by the relation 1 wavelength = 6 438.469 6 angstroms.

[b] The international nautical mile of 1 852 meters (6 076.103 33 . . . feet) was adopted effective July 1, 1954 for use in the United States. The value formerly used in the United States was 6 080.20 feet = 1 nautical (geographical or sea) mile

CONVERSION FACTORS – LENGTH

Desired Units / Given Units	Inch	Foot	Yard	Mile	Micron	Millimeter	Centimeter	Meter	Kilometer
Inch	1	83.33 $\times 10^{-3}$	27.778 $\times 10^{-3}$	1.578 $\times 10^{-5}$	2.54 $\times 10^{4}$	25.4	2.54	2.54 $\times 10^{-2}$	2.54 $\times 10^{-5}$
Foot	12	1	3333	1.894 $\times 10^{-4}$	30.48 $\times 10^{4}$	304.8	30.48	30.48 $\times 10^{-2}$	30.48 $\times 10^{-5}$
Yard	36	3	1	5.682 $\times 10^{-4}$	91.44 $\times 10^{4}$	914.4	91.44	91.44 $\times 10^{-2}$	91.44 $\times 10^{-5}$
Mile	6.3360 $\times 10^{4}$	5280	1760	1	1.6094 $\times 10^{9}$	1.6094 $\times 10^{6}$	1.6094 $\times 10^{5}$	1.6094 $\times 10^{3}$	1.6094
Micron	3.937 $\times 10^{-5}$	32.808 $\times 10^{-7}$	10.94 $\times 10^{-7}$	62.137 $\times 10^{-11}$	1	1×10^{-3}	1×10^{-4}	1×10^{-6}	1×10^{-9}
Millimeter	3.937 $\times 10^{-2}$	32.808 $\times 10^{-4}$	10.94 $\times 10^{-4}$	62.137 $\times 10^{-8}$	1×10^{3}	1	0.1	1×10^{-3}	1×10^{-6}
Centimeter	3.937 $\times 10^{-1}$	33.808 $\times 10^{-3}$	10.94 $\times 10^{-3}$	62.137 $\times 10^{-7}$	1×10^{4}	10	1	1×10^{-2}	1×10^{-5}
Meter	39.37	32.808 $\times 10^{-1}$	10.94 $\times 10^{-1}$	62.137 $\times 10^{-5}$	1×10^{6}	1×10^{3}	1×10^{2}	1	1×10^{-3}
Kilometer	3.937 $\times 10^{4}$	32.808 $\times 10^{2}$	10.94 $\times 10^{2}$	62.137 $\times 10^{-2}$	1×10^{9}	1×10^{6}	1×10^{5}	1×10^{3}	1

To convert a value from a given unit to a desired unit, multiply the given value by the factor opposite the given units and beneath the desired units.

DECIMALS OF AN INCH FOR EACH 64TH
OF AN INCH WITH MILLIMETER EQUIVALENTS

Fraction	1/64ths	Decimal	Millimeters (approx.)	Fraction	1/64ths	Decimal	Millimeters (approx.)
.....	1	.015625	0.397	.....	33	.515625	13.097
1/32	2	.03125	0.794	17/32	34	.53125	13.494
.....	3	.046875	1.191	.....	35	.546875	13.891
1/16	4	.0625	1.588	9/16	36	.5625	14.288
.....	5	.078125	1.984	.....	37	.578125	14.684
3/32	6	.09375	2.381	19/32	38	.59375	15.081
.....	7	.109375	2.778	.....	39	.609375	15.478
1/8	8	.125	3.175	5/8	40	.625	15.875
.....	9	.140625	3.572	.....	41	.640625	16.272
5/32	10	.15625	3.969	21/32	42	.65625	16.669
.....	11	.171875	4.366	.....	43	.671875	17.066
3/16	12	.1875	4.763	11/16	44	.6875	17.463
.....	13	.203125	5.159	.....	45	.703125	17.859
7/32	14	.21875	5.556	23/32	46	.71875	18.256
.....	15	.234375	5.953	.....	47	.734375	18.653
1/4	16	.250	6.350	3/4	48	.750	19.050
.....	17	.265625	6.747	.....	49	.765625	19.447
9/32	18	.28125	7.144	25/32	50	.78125	19.844
.....	19	.296875	7.541	.....	51	.796875	20.241
5/16	20	.3125	7.938	13/16	52	.8125	20.638
.....	21	.328125	8.334	.....	53	.828125	21.034
11/32	22	.34375	8.731	27/32	54	.84375	21.431
.....	23	.359375	9.128	.....	55	.859375	21.828
3/8	24	.375	9.525	7/8	56	.875	22.225
.....	25	.390625	9.922	.....	57	.890625	22.622
13/32	26	.40625	10.319	29/32	58	.90625	23.019
.....	27	.421875	10.716	.....	59	.921875	23.416
7/16	28	.4375	11.113	15/16	60	.9375	23.813
.....	29	.453125	11.509	.....	61	.953125	24.209
15/32	30	.46875	11.906	31/32	62	.96875	24.606
.....	31	.484375	12.303	.....	63	.984375	25.003
1/2	32	.500	12.700	1	64	1.000	25.400

DECIMALS OF A FOOT FOR EACH 32ND OF AN INCH

Inch	0"	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"
0	0	.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167
1/32	.0026	.0859	.1693	.2526	.3359	.4193	.5026	.5859	.6693	.7526	.8359	.9193
1/16	.0052	.0885	.1719	.2552	.3385	.4219	.5052	.5885	.6719	.7552	.8385	.9219
3/32	.0078	.0911	.1745	.2578	.3411	.4245	.5078	.5911	.6745	.7578	.8411	.9245
1/8	.0104	.0938	.1771	.2604	.3438	.4271	.5104	.5938	.6771	.7604	.8438	.9271
5/32	.0130	.0964	.1797	.2630	.3464	.4297	.5130	.5964	.6797	.7630	.8464	.9297
3/16	.0156	.0990	.1823	.2656	.3490	.4323	.5156	.5990	.6823	.7656	.8490	.9323
7/32	.0182	.1016	.1849	.2682	.3516	.4349	.5182	.6016	.6849	.7682	.8516	.9349
1/4	.0208	.1042	.1875	.2708	.3542	.4375	.5208	.6042	.6875	.7708	.8542	.9375
9/32	.0234	.1068	.1901	.2734	.3568	.4401	.5234	.6068	.6901	.7734	.8568	.9401
5/16	.0260	.1094	.1927	.2760	.3594	.4427	.5260	.6094	.6927	.7760	.8594	.9427
11/32	.0286	.1120	.1953	.2786	.3620	.4453	.5286	.6120	.6953	.7786	.8620	.9453
3/8	.0313	.1146	.1979	.2812	.3646	.4479	.5313	.6146	.6979	.7813	.8646	.9479
13/32	.0339	.1172	.2005	.2839	.3672	.4505	.5339	.6172	.7005	.7839	.8672	.9505
7/16	.0365	.1198	.2031	.2865	.3698	.4531	.5365	.6198	.7031	.7865	.8698	.9531
15/32	.0391	.1224	2057	.2891	.3724	.4557	.5391	.6224	.7057	.7891	.8724	.9557
1/2	.0417	.1250	.2083	.2917	.3750	.4583	.5417	.6250	.7083	.7917	.8750	.9583
17/32	.0443	.1276	.2109	.2943	.3776	.4609	.5443	.6276	.7109	.7943	.8776	.9609
9/16	.0469	.1302	.2135	.2969	.3802	.4635	.5469	.6302	.7135	.7969	.8802	.9635
19/32	.0495	.1328	.2161	.2995	.3828	.4661	.5495	.6328	.7161	.7995	.8828	.9661
5/8	.0521	.1354	.2188	.3021	.3854	.4688	.5521	.6354	.7188	.8021	.8854	.9688
21/32	.0547	.1380	.2214	.3047	.3880	.4714	.5547	.6380	.7214	.8047	.8880	.9714
11/16	.0573	.1406	.2240	.3073	.3906	.4740	.5573	.6406	.7240	.8073	.8906	.9740
23/32	.0599	.1432	.2266	.3099	.3932	.4766	.5599	.6432	.7266	.8099	.8932	.9766
3/4	.0625	.1458	.2292	.3125	.3958	.4792	.5625	.6458	.7292	.8125	.8958	.9792
25/32	.0651	.1484	.2318	.3151	.3984	.4818	.5651	.6484	7318	.8151	.8984	.9818
13/16	.0677	.1510	.2344	.3177	.4010	.4844	.5677	.6510	.7344	.8177	.9010	.9844
27/32	.0703	.1536	.2370	.3203	.4036	.4870	.5703	.6536	.7370	.8203	.9036	.9870
7/8	.0729	.1563	.2396	.3229	.4063	.4896	.5729	.6563	.7396	.8229	.9063	.9896
29/32	.0755	.1589	.2422	.3255	.4089	.4922	.5755	.6589	.7422	.8255	.9089	.9922
15/16	.0781	.1615	.2448	.3281	.4115	.4948	.5781	.6615	.7448	.8281	.9115	.9948
31/32	.0807	.1641	.2474	.3307	.4141	.4974	.5807	.6641	.7474	.8307	.9141	.9974

SECTION 5 **AREA**

Table of Equivalents of Area 5-1

TABLE OF EQUIVALENTS OF AREA

Units		Square inches	Square links	Square feet	Square yards	Square rods	Square chains
1 square inch	=	1	0.015 942 3	0.006 944 44	0.000 771 605	0.000 025 507 6	0.000 001 594 23
1 square link	=	62.7264	1	0.4356	0.0484	0.0016	0.0001
1 square foot	=	144	2.295 684	1	0.111 111 1	0.003 673 09	0.000 229 568
1 square yard	=	1296	20.6612	9	1	0.033 057 85	0.002 066 12
1 square rod	=	39 204	625	272.25	30.25	1	0.0025
1 square chain	=	627 264	10 000	4356	484	16	1
1 acre	=	6 272 640	100 000	43 560	4840	160	10
1 square mile	=	4 014 489 600	64 000 000	27 878 400	3 097 600	102 400	6400
1 square centimeter	=	0.154 999 69	0.002 471 04	0.001 076 387	0.000 119 598 5	0.000 003 953 67	0.000 000 247 104
1 square meter	=	1549.9969	24.7104	10.763 87	1.195 985	0.039 536 7	0.002 471 04
1 hectare	=	15 499 969	247 104	107 638.7	11 959.85	395.367	2.. 7104

Units		Acres	Square miles	Square centimeters	Square meters	Hectares
1 square inch	=	0.000 000 159 423	0.000 000 000 249 1	6.451 626	0.000 645 162 6	0.000 000 064 516
1 square link	=	0.000 01	0.000 000 015 625	404.6873	0.040 468 73	0.000 004 046 87
1 square foot	=	0.000 022 956 8	0.000 000 035 870 1	929.0341	0.092 903 41	0.000 009 290 34
1 square yard	=	0.000 206 612	0.000 000 322 831	8361.307	0.836 130 7	0.000 083 613 1
1 square rod	=	0.006 25	0.000 009 765 625	252 929.5	25.292 95	0.002 529 295
1 square chain	=	0.1	0.000 156 25	4 046 873	404.6873	0.040 468 7
1 acre	=	1	0.001 562 5	40 468 726	4046.873	0.404 687
1 square mile	=	640	1	25 899 984 703	2 589 998	258.9998
1 square centimeter	=	0.000 000 024 710 4	0.000 000 000 038 610 06	1	0.0001	0.000 000 01
1 square meter	=	0.000 247 104	0.000 000 386 100 6	10 000	1	0.0001
1 hectare	=	2.471 04	0.003 861 006	100 000 000	10 000	1

AREAS OR SURFACES

1 acre[1]	43 560 square feet. 4 840 square yards. 0.405 hectare.
1 are	119.596 square yards. 0.025 acre.
1 hectare	2.471 acres.
[1 square (building)]	100 square feet.
1 square centimeter (cm²)	0.155 square inch.
1 square decimeter (dm²)	15.500 square inches.
1 square foot (sq ft)	929.034 square centimeters.
1 square inch (sq in.)	6.452 square centimeters
1 square kilometer (km²)	247.104 acres. 0.386 square mile.
1 square meter (m²)	1.196 square yards. 10.764 square feet.
1 square mile (sq mi)	259.000 hectares.
1 square millimeter (mm²)	0.002 square inch.
1 square rod (sq rd), sq pole, or sq perch	25.293 square meters.
1 square yard (sq yd)	0.836 square meter.

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[1] The question is often asked as to the length of a side of an acre of ground. An acre is a unit of area containing 43 560 square feet. It is not necessarily square, or even rectangular. But, if it is square then the length of a side is equal to $\sqrt{43\ 560}=208.710+$ feet.

SECTION 6 VELOCITY

Table of Equivalents of Velocities 6-1
Conversion Factors – Velocity 6-2
Meters per Second to Miles per Hour, Feet per Second, Kilometers per Hour, Knots, Feet per Minute 6-3
Feet per Second to Meters per Second, Feet per Minute, Miles per Hour, Kilometers per Hour, Knots 6-4
Relationship Between Velocity Head and Velocity 6-6

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TABLE OF EQUIVALENTS OF VELOCITIES

Velocity; speed:

- 1 meter per second (m. sec.$^{-1}$, mps)
  - = 3.6 km. hr.$^{-1}$
  - = 1.94254 knots
  - = 2.23694 mi. hr.$^{-1}$
  - = 3.28084 ft. sec.$^{-1}$
  - = 196.850 ft. min.$^{-1}$
  - = 0.77742 °lat. day^{-1}
- 1 kilometer per hour (km. hr.$^{-1}$, kph)
  - = 0.277778 m. sec.$^{-1}$
  - = 0.539593 knot
  - = 0.621371 mi. hr.$^{-1}$
  - = 0.911344 ft. sec.$^{-1}$
  - = 0.21595 °lat. day^{-1}
- 1 degree of latitude per day (°lat. day^{-1})
  - = 1.2863 m. sec.$^{-1}$
  - = 4.6307 km. hr.$^{-1}$
  - = 2.4987 $\cong$ 2.5 knots
  - = 2.8774 mi. hr.
- 1 knot
  - = 1 naut. mi. hr.$^{-1}$
  - = 1.15155 mi. hr.$^{-1}$
  - = 1.68895 ft. sec.$^{-1}$
  - = 0.514791 m. sec.$^{-1}$
  - = 1.85325 km. hr.$^{-1}$
  - = 101.337 ft. min.$^{-1}$
  - = 0.40021 $\cong$ 0.4 °lat. day^{-1}
- 1 mile per hour (mi. hr.$^{-1}$, mph)
  - = 0.868391 knot
  - = 1.46667 ft. sec.$^{-1}$
  - = 0.44704 m. sec.$^{-1}$
  - = 1.609344 km. hr.$^{-1}$
  - = 88 ft. min.$^{-1}$
  - = 0.34754 °lat. day^{-1}
- 1 foot per second (ft. sec.$^{-1}$, fps)
  - = 0.592085 knot
  - = 0.681818 mi. hr.$^{-1}$
  - = 60 ft. min.$^{-1}$
  - = 0.3048 m. sec.$^{-1}$
  - = 1.09728 km. hr.$^{-1}$
- 1 foot per minute (ft. min.$^{-1}$, fpm)
  - = 0.00986808 knot
  - = 0.0113636 mi. hr.$^{-1}$
  - = 0.00508 m. sec.$^{-1}$
  - = 0.018288 km. hr.$^{-1}$

See Reference No. 1

CONVERSION FACTORS – VELOCITY

Given units \ Desired units	m/sec	ft/sec	ft/min	km/hr	mi/hr	knots	mi/day
m/sec	1.0	3.2808	1.9685×10^{2}	3.6	2.2369	1.9425	5.3687×10
ft/sec	3.0480×10^{-1}	1.0	60	1.0973	6.8182×10^{-1}	5.9209×10^{-1}	1.6364×10
ft/min	5.0080×10^{-3}	1.6667×10^{-2}	1.0	1.8288×10^{-2}	1.1364×10^{-2}	9.8681×10^{-3}	2.7273×10^{-1}
km/hr	2.7778×10^{-1}	9.1134×10^{-1}	5.4681×10	1.0	6.2137×10^{-1}	5.3959×10^{-1}	1.4913×10
mi/hr	4.4707×10^{-1}	1.4667	88.0	1.6093	1.0	8.6839×10^{-1}	24
knots	5.1479×10^{-1}	1.6890	1.0134×10^{2}	1.8533	1.1516	1.0	2.7637×10
mi/day	1.8627×10^{-2}	6.1111×10^{-2}	3.6667	6.7056×10^{-2}	4.1667×10^{-2}	3.6183×10^{-2}	1.0

To convert a value from a given unit to a desired unit, multiply the given value by the factor opposite the given units and beneath the desired units.

METERS PER SECOND TO MILES PER HOUR, FEET PER SECOND, KILOMETERS PER HOUR, KNOTS, FEET PER MINUTE

Meters per second	Miles per hour	Feet per second	Kilo-meters per hour	Knots	Feet per minute	Meters per second	Miles per hour	Feet per second	Kilo-meters per hour	Knots	Feet per minute
1	2.2	3.3	3.6	1.9	197	56	125.3	183.7	201.6	108.8	11024
2	4.5	6.6	7.2	3.9	394	57	127.5	187.0	205.2	110.7	11220
3	6.7	9.8	10.8	5.8	591	58	129.7	190.3	208.8	112.7	11417
4	8.9	13.1	14.4	7.8	787	59	132.0	193.6	212.4	114.6	11614
5	11.2	16.4	18.0	9.7	984	60	134.2	196.9	216.0	116.6	11811
6	13.4	19.7	21.6	11.7	1181	61	136.5	200.1	219.6	118.5	12008
7	15.7	23.0	25.2	13.6	1378	62	138.7	203.4	223.2	120.4	12205
8	17.9	26.2	28.8	15.5	1575	63	140.9	206.7	226.8	122.4	12402
9	20.1	29.5	32.4	17.5	1772	64	143.2	210.0	230.4	124.3	12598
10	22.4	32.8	36.0	19.4	1969	65	145.4	213.3	234.0	126.3	12795
11	24.6	36.1	39.6	21.4	2165	66	147.6	216.5	237.6	128.2	12992
12	26.8	39.4	43.2	23.3	2362	67	149.9	219.8	241.2	130.1	13189
13	29.1	42.7	46.8	25.3	2559	68	152.1	223.1	244.8	132.1	13386
14	31.3	45.9	50.4	27.2	2756	69	154.3	226.4	248.4	134.0	13583
15	33.6	49.2	54.0	29.1	2953	70	156.6	229.7	252.0	136.0	13780
16	35.8	52.5	57.6	31.1	3150	71	158.8	232.9	255.6	137.9	13976
17	38.0	55.8	61.2	33.0	3346	72	161.1	236.2	259.2	139.9	14173
18	40.3	59.1	64.8	35.0	3543	73	163.3	239.5	262.8	141.8	14370
19	42.5	62.3	68.4	36.9	3740	74	165.5	242.8	266.4	143.7	14567
20	44.7	65.6	72.0	38.9	3937	75	167.8	246.1	270.0	145.7	14764
21	47.0	68.9	75.6	40.8	4134	76	170.0	249.3	273.6	147.6	14961
22	49.2	72.2	79.2	42.7	4331	77	172.2	252.6	277.2	149.6	15157
23	51.4	75.5	82.8	44.7	4528	78	174.5	255.9	280.8	151.5	15354
24	53.7	78.7	86.4	46.6	4724	79	176.7	259.2	284.4	153.5	15551
25	55.9	82.0	90.0	48.6	4921	80	179.0	262.5	288.0	155.4	15748
26	58.2	85.3	93.6	50.5	5118	81	181.2	265.7	291.6	157.3	15945
27	60.4	88.6	97.2	52.4	5315	82	183.4	269.0	295.2	159.3	16142
28	62.6	91.9	100.8	54.4	5512	83	185.7	272.3	298.8	161.2	16339
29	64.9	95.1	104.4	56.3	5709	84	187.9	275.6	302.4	163.2	16535
30	67.1	98.4	108.0	58.3	5906	85	190.1	278.9	306.0	165.1	16732
31	69.3	101.7	111.6	60.2	6102	86	192.4	282.2	309.6	167.1	16929
32	71.6	105.0	115.2	62.2	6299	87	194.6	285.4	313.2	169.0	17126
33	73.8	108.3	118.8	64.1	6496	88	196.9	288.7	316.8	170.9	17323
34	76.1	111.5	122.4	66.0	6693	89	199.1	292.0	320.4	172.9	17520
35	78.3	114.8	126.0	68.0	6890	90	201.3	295.3	324.0	174.8	17717
36	80.5	118.1	129.6	69.9	7087	91	203.6	298.6	327.6	176.8	17913
37	82.8	121.4	133.2	71.9	7283	92	205.8	301.8	331.2	178.7	18110
38	85.0	124.7	136.8	73.8	7480	93	208.0	305.1	334.8	180.7	18307
39	87.2	128.0	140.4	75.8	7677	94	210.3	308.4	338.4	182.6	18504
40	89.5	131.2	144.0	77.7	7874	95	212.5	311.7	342.0	184.5	18701
41	91.7	134.5	147.6	79.6	8071	96	214.7	315.0	345.6	186.5	18898
42	94.0	137.8	151.2	81.6	8268	97	217.0	318.2	349.2	188.4	19094
43	96.2	141.1	154.8	83.5	8465	98	219.2	321.5	352.8	190.4	19291
44	98.4	144.4	158.4	85.5	8661	99	221.5	324.8	356.4	192.3	19488
45	100.7	147.6	162.0	87.4	8858	100	223.7	328.1	360.0	194.3	19685
46	102.9	150.9	165.6	89.4	9055	110	246.1	360.9	396.0	213.7	19882
47	105.1	154.2	169.2	91.3	9252	120	268.4	393.7	432.0	233.1	20079
48	107.4	157.5	172.8	93.2	9449	130	290.8	426.5	468.0	252.5	20276
49	109.6	160.8	176.4	95.2	9646	140	313.2	459.3	504.0	272.0	20472
50	111.8	164.0	180.0	97.1	9843	150	335.5	492.1	540.0	291.4	20669
51	114.1	167.3	183.6	99.1	10039	160	357.9	524.9	576.0	310.8	20866
52	116.3	170.6	187.2	101.0	10236	170	380.3	557.7	612.0	330.2	21063
53	118.6	173.9	190.8	103.0	10433	180	402.6	590.6	648.0	349.7	21260
54	120.9	177.2	194.4	104.9	10630	190	425.0	623.4	684.0	369.1	21457
55	123.0	180.4	198.0	106.8	10827	200	447.4	656.2	720.0	388.5	21654

See Reference No. 1

FEET PER SECOND TO METERS PER SECOND, FEET PER MINUTE, MILES PER HOUR, KILOMETERS PER HOUR, KNOTS

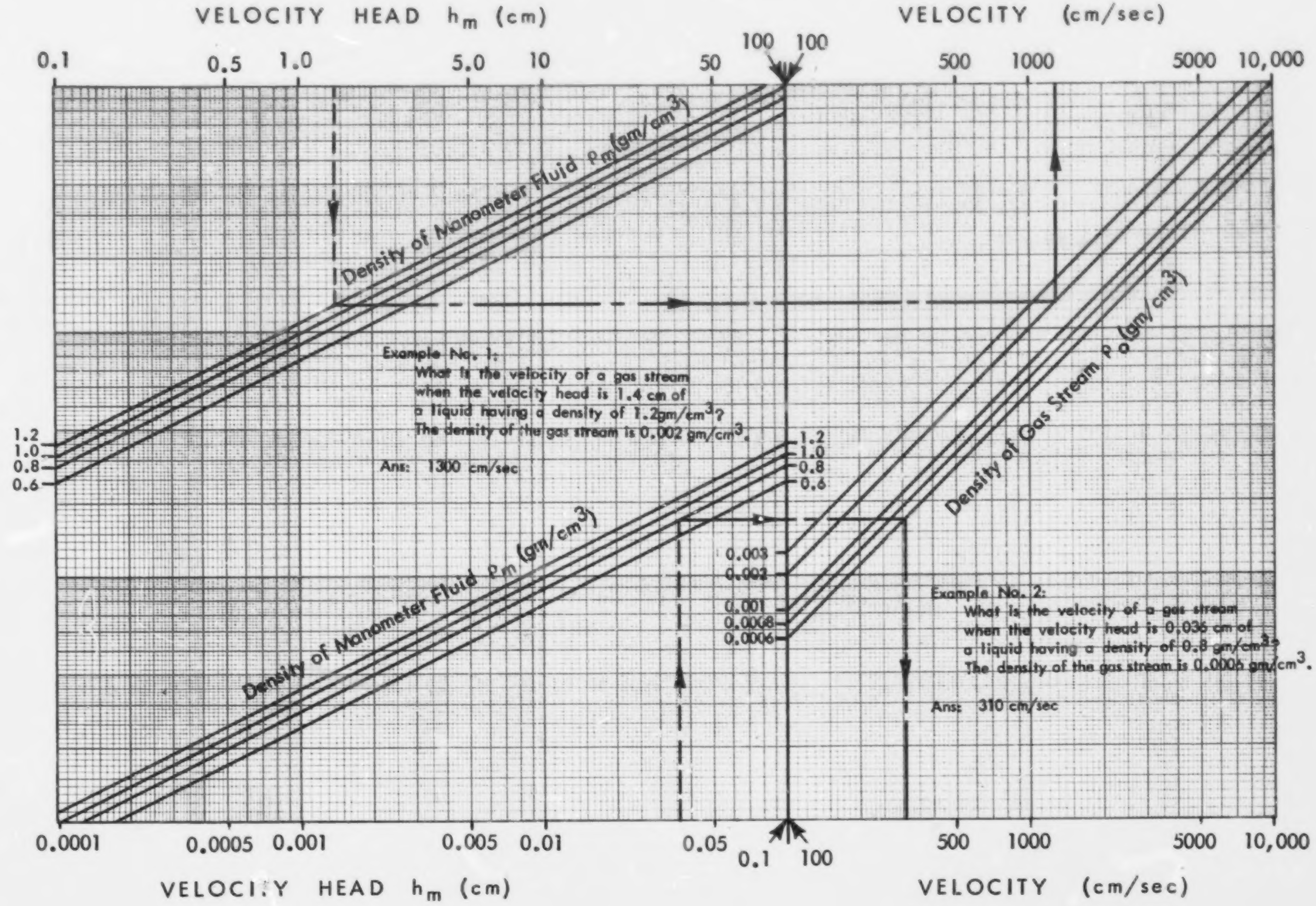
Feet per second	Meters per second	Feet per minute	Miles per hour	Kilometers per hour	Knots	Feet per second	Meters per second	Feet per minute	Miles per hour	Kilometers per hour	Knots
1	0.31	60	0.68	1.10	0.59	36	10.98	2160	24.55	39.50	21.32
2	0.61	120	1.36	2.19	1.18	37	11.29	2220	25.23	40.60	21.91
3	0.92	180	2.05	3.29	1.78	38	11.59	2280	25.91	41.70	22.50
4	1.22	240	2.73	4.39	2.37	39	11.90	2340	26.59	42.79	23.09
5	1.53	300	3.41	5.49	2.96	40	12.20	2400	27.27	43.89	23.68
6	1.83	360	4.09	6.58	3.55	41	12.51	2460	27.95	44.99	24.28
7	2.14	420	4.77	7.68	4.14	42	12.81	2520	28.64	46.09	24.87
8	2.44	480	5.45	8.78	4.74	43	13.12	2580	29.32	47.18	25.46
9	2.75	540	6.14	9.88	5.33	44	13.42	2640	30.00	48.28	26.05
10	3.05	600	6.82	10.97	5.92	45	13.73	2700	30.68	49.38	26.64
11	3.36	660	7.50	12.07	6.51	46	14.03	2760	31.36	50.47	27.24
12	3.66	720	8.18	13.17	7.11	47	14.34	2820	32.05	51.57	27.83
13	3.97	780	8.86	14.26	7.70	48	14.64	2880	32.73	52.67	28.42
14	4.27	840	9.55	15.36	8.29	49	14.95	2940	33.41	53.77	29.01
15	4.58	900	10.23	16.46	8.88	50	15.25	3000	34.09	54.86	29.60
16	4.88	960	10.91	17.56	9.47	51	15.56	3060	34.77	55.96	30.20
17	5.19	1020	11.59	18.65	10.07	52	15.86	3120	35.45	57.06	30.79
18	5.49	1080	12.27	19.75	10.66	53	16.17	3180	36.14	58.16	31.38
19	5.80	1140	12.95	20.85	11.25	54	16.47	3240	36.82	59.25	31.97
20	6.10	1200	13.64	21.95	11.84	55	16.78	3300	37.50	60.35	32.56
21	6.41	1260	14.32	23.04	12.43	56	17.08	3360	38.18	61.45	33.16
22	6.71	1320	15.00	24.14	13.03	57	17.39	3420	38.86	62.54	33.75
23	7.02	1380	15.68	25.24	13.62	58	17.69	3480	39.54	63.64	34.34
24	7.32	1440	16.36	26.33	14.21	59	18.00	3540	40.23	64.74	34.93
25	7.63	1500	17.05	27.43	14.80	60	18.30	3600	40.91	65.84	35.53
26	7.93	1560	17.73	28.53	15.39	61	18.61	3660	41.59	66.93	36.12
27	8.24	1620	18.41	29.63	15.99	62	18.91	3720	42.27	68.03	36.71
28	8.54	1680	19.09	30.72	16.58	63	19.22	3780	42.95	69.13	37.30
29	8.85	1740	19.77	31.82	17.17	64	19.52	3840	43.64	70.23	37.89
30	9.15	1800	20.45	32.92	17.76	65	19.83	3900	44.32	71.32	38.49
31	9.46	1860	21.14	34.02	18.35	66	20.13	3960	45.00	72.42	39.08
32	9.76	1920	21.82	35.11	18.95	67	20.44	4020	45.68	73.52	39.67
33	10.07	1980	22.50	36.21	19.54	68	20.74	4080	46.36	74.62	40.26
34	10.37	2040	23.18	37.31	20.13	69	21.05	4140	47.05	75.71	40.85
35	10.68	2100	23.86	38.40	20.72	70	21.35	4200	47.73	76.81	41.45

FEET PER SECOND TO METERS PER SECOND, FEET PER MINUTE, MILES PER HOUR, KILOMETERS PER HOUR, KNOTS

(continued)

Feet per second	Meters per second	Feet per minute	Miles per hour	Kilo-meters per hour	Knots	Feet per second	Meters per second	Feet per minute	Miles per hour	Kilo-meters per hour	Knots
71	21.66	4260	48.41	77.91	42.04	130	39.65	7800	88.64	142.65	76.97
72	21.96	4320	49.09	79.00	42.63	135	41.18	8100	92.05	148.13	79.93
73	22.27	4380	49.77	80.10	43.22	140	42.70	8400	95.45	153.62	82.89
74	22.57	4440	50.45	81.20	43.81	145	44.23	8700	98.86	159.11	85.85
75	22.88	4500	51.14	82.30	44.41	150	45.75	9000	102.27	164.59	88.81
76	23.18	4560	51.82	83.39	45.00	155	47.28	9300	105.68	170.08	91.77
77	23.49	4620	52.50	84.49	45.59	160	48.80	9600	109.09	175.56	94.73
78	23.79	4680	53.18	85.59	46.18	165	50.33	9900	112.50	181.05	97.69
79	24.10	4740	53.86	86.69	46.77	170	51.85	10200	115.91	186.54	100.65
80	24.40	4800	54.55	87.78	47.37	175	53.38	10500	119.32	192.02	103.61
81	24.71	4860	55.23	88.88	47.96	180	54.90	10800	122.73	197.51	106.58
82	25.01	4920	55.91	89.98	48.55	185	56.43	11100	126.14	203.00	109.54
83	25.32	4980	56.59	91.07	49.14	190	57.95	11400	129.55	208.48	112.50
84	25.62	5040	57.27	92.17	49.74	195	59.48	11700	132.95	213.97	115.46
85	25.93	5100	57.95	93.27	50.33	200	61.00	12000	136.36	219.46	118.42
86	26.23	5160	58.64	94.37	50.92	225	68.63	13500	153.41	246.89	133.22
87	26.54	5220	59.32	95.46	51.51	250	76.25	15000	170.45	274.32	148.02
88	26.84	5280	60.00	96.56	52.10	275	83.88	16500	187.50	301.75	162.82
89	27.15	5340	60.68	97.66	52.70	300	91.50	18000	204.55	329.18	177.63
90	27.45	5400	61.36	98.76	53.29	325	99.13	19500	221.59	356.62	192.43
91	27.76	5460	62.05	99.85	53.88	350	106.75	21000	238.64	384.05	207.23
92	28.06	5520	62.73	100.95	54.47	375	114.38	22500	255.68	411.48	222.03
93	28.37	5580	63.41	102.05	55.06	400	122.00	24000	272.73	438.91	236.83
94	28.67	5640	64.09	103.14	55.66	425	129.63	25500	289.77	466.34	251.64
95	29.98	5700	64.77	104.24	56.25	450	137.25	27000	306.82	493.78	266.44
96	29.28	5760	65.45	105.34	56.84	475	144.88	28500	323.86	521.21	281.24
97	29.59	5820	66.14	106.44	57.43	500	152.50	30000	340.91	548.64	296.04
98	29.89	5880	66.82	107.53	58.02	525	160.13	31500	357.95	576.07	310.84
99	30.20	5940	67.50	108.63	58.62	550	167.75	33000	375.00	603.50	325.65
100	30.50	6000	68.18	109.73	59.21	575	175.38	34500	392.05	630.94	340.45
105	32.03	6300	71.59	115.21	62.17	600	183.00	36000	409.09	658.37	355.25
110	33.55	6600	75.00	120.70	65.13	625	190.63	37500	426.14	685.80	370.05
115	35.08	6900	78.41	126.19	68.09	650	198.25	39000	443.18	713.23	384.86
120	36.60	7200	81.82	131.67	71.05	675	205.88	40500	460.23	740.66	399.66
125	38.13	7500	85.23	137.16	74.01	700	213.50	42000	477.27	768.10	414.46

RELATIONSHIP BETWEEN VELOCITY HEAD AND VELOCITY



Example No. 1:
What is the velocity of a gas stream when the velocity head is 1.4 cm of a liquid having a density of 1.2gm/cm^3? The density of the gas stream is 0.002 gm/cm^3.

Ans: 1300 cm/sec

Example No. 2:
What is the velocity of a gas stream when the velocity head is 0.036 cm of a liquid having a density of 0.8 gm/cm^3? The density of the gas stream is 0.0006 gm/cm^3.

Ans: 310 cm/sec

SECTION 7 CAPACITIES, VOLUMES AND FLOW RATES

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EQUIVALENTS OF CAPACITIES OR VOLUMES

1 barrel (bbl), liquid	31 to 42 gallons.[j]
1 barrel (bbl), standard for fruits, vegetables, and other dry commodities except cranberries	7 056 cubic inches. 105 dry quarts. 3.281 bushels, struck measure.
1 barrel (bbl), standard, cranberry	5 826 cubic inches. 86 45/64 dry quarts. 2.709 bushels, struck measure.
1 bushel (bu) (U. S.) struck measure	2 150.42 cubic inches (exactly). 35.238 liters.
[1 bushel, heaped (U. S.)]	2 747.715 cubic inches. 1.278 bushels, struck measure.[k]
[1 bushel (bu) (British Imperial) (struck measure)]	1.032 U. S. bushels, struck measure. 2 219.36 cubic inches.
1 cord (cd) (firewood)	128 cubic feet.
1 cubic centimeter (cm³)	0.061 cubic inch.
1 cubic decimeter (dm³)	61.023 cubic inches.
1 cubic foot (cu ft)	7.481 gallons. 28.317 cubic decimeters.
1 cu inch (cu in.)	0.554 fluid ounce. 4.433 fluid drams. 16.387 cubic centimeters.
1 cubic meter (m³)	1.308 cubic yards.
1 cubic yard (cu yd)	0.765 cubic meter.
1 cup, measuring	8 fluid ounces. ½ liquid pint.
1 dram, fluid (or liquid) (fl dr or ƒʒ) (U. S.)	⅛ fluid ounce. 0.226 cubic inch. 3.697 milliliters. 1.041 British fluid drachms.
[1 drachm, fluid (fl dr) (British)]	0.961 U. S. fluid dram. 0.217 cubic inch. 3. 552 milliliters.
1 dekaliter (dkl)	2.642 gallons. 1.135 pecks.
1 gallon (gal) (U. S.)	231 cubic inches. 3.785 liters. 0.833 British gallon. 128 U. S. fluid ounces.
[1 gallon (gal) (British Imperial)]	277.42 cubic inches. 1.201 U. S. gallons. 4.546 liters. 160 British fluid ounces.
1 gill (gi)	7.219 cubic inches. 4 fluid ounces. 0.118 liter.
1 hectoliter (hl)	26.418 gallons. 2.838 bushels.
1 liter	1.057 liquid quarts. 0.908 dry quart. 61.025 cubic inches.
1 milliliter (ml)	0.271 fluid dram. 16.231 minims.

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[j] There are a variety of "barrels" established by law or usage. For example, Federal taxes on fermented liquors are based on a barrel of 31 gallons; many State laws fix the "barrel for liquids" as 31½ gallons; one State fixes a 36-gallon barrel for cistern measurement; Federal law recognizes a 40-gallon barrel for "proof spirits"; by custom, 42 gallons comprise a barrel of crude oil or petroleum products for statistical purposes, and this equivalent is recognized "for liquids" by four States.

[k] Frequently recognized as 1¼ bushels, struck measure.

See Reference No. 3

EQUIVALENTS OF CAPACITIES OR VOLUMES
(continued)

	0.061 cubic inch.
1 ounce, fluid (or liquid) (fl oz or f℥) (U. S.)	1.805 cubic inches. 29.573 milliliters. 1.041 British fluid ounces.
[1 ounce, fluid (fl oz) (British)]	0.961 U. S. fluid ounce. 1.734 cubic inches. 28.412 milliliters.
1 peck (pk)	8.810 liters.
1 pint (pt), dry	33.600 cubic inches. 0.551 liter.
1 pint (pt), liquid	28.875 cubic inches (exactly). 0.473 liter.
1 quart (qt), dry (U. S.)	67.201 cubic inches. 1.101 liters. 0.969 British quart.
1 quart (qt), liquid (U. S.)	57.75 cubic inches (exactly). 0.946 liter. 0.833 British quart.
[1 quart (qt) (British)]	69.354 cubic inches. 1.032 U. S. dry quarts. 1.201 U. S. liquid quarts.
1 tablespoon	3 teaspoons.[1] 4 fluid drams. ½ fluid ounce.
1 teaspoon	⅓ tablespoon.[1] 1⅓ fluid drams.[1]
1 water ton (English)	270.91 U. S. gallons. 224 British Imperial gallons (exactly).

---

[1] The equivalent "1 teaspoon = 1⅓ fluid drams" has been found by the Bureau to correspond more closely with the actual capacities of "measuring" and silver teaspoons than the equivalent "1 teaspoon = 1 fluid dram," which is given by a number of dictionaries.

UNITS OF CAPACITY DRY MEASURE

Units	Dry pints	Dry quarts	Pecks	Bushels
1 dry pint =	**1**	**0.5**	**0.0625**	**0.015 625**
1 dry quart =	**2**	**1**	**0.125**	**0.031 25**
1 peck =	**16**	**8**	**1**	**0.25**
1 bushel =	**64**	**32**	**4**	**1**
1 liter =	1.816 21	0.908 103	0.113 513	0.028 378
1 dekaliter =	18.1621	9.081 03	1.135 13	0.283 78
1 cubic inch =	0.029 761 6	0.014 880 8	0.001 860 10	0.000 465 025
1 cubic foot =	51.428 093	25.714 047	3.214 255 8	0.803 563 95

Units	Liters	Dekaliters	Cubic inches	Cubic feet
1 dry pint =	0.550 598	0.055 059 8	**33.600 312 5**	0.019 444 63
1 dry quart =	1.101 197	0.110 119 7	**67.200 625**	0.038 889 25
1 peck =	8.809 57	0.880 957	**537.605**	0.311 114
1 bushel =	35.2383	3.523 83	**2150.42**	1.244 456
1 liter =	**1**	**0.1**	61.0251	0.035 315 4
1 dekaliter =	**10**	**1**	610.251	0.353 154
1 cubic inch =	0.016 386 7	0.001 638 67	**1**	0.000 578 703 7
1 cubic foot =	28.316 22	2.831 622	**1728**	**1**

UNITS OF CAPACITY LIQUID MEASURE

Units	Minims	Fluid drams	Fluid ounces	Gills	Liquid pints
1 minim =	**1**	0.016 666 7	0.002 083 33	0.000 520 833	0.000 130 208
1 fluid dram =	**60**	**1**	**0.125**	**0.031 25**	**0.007 812 5**
1 fluid ounce =	**480**	**8**	**1**	**0.25**	**0.0625**
1 gill =	**1920**	**32**	**4**	**1**	**0.25**
1 liquid pint =	**7680**	**128**	**16**	**4**	**1**
1 liquid quart =	**15 360**	**256**	**32**	**8**	**2**
1 gallon =	**61 440**	**1024**	**128**	**32**	**8**
1 milliliter =	16.2311	0.270 518	0.033 814 8	0.008 453 69	0.002 113 42
1 liter =	16 231.1	270.518	33.8148	8.453 69	2.113 42
1 cubic inch =	265.974	4.432 90	0.554 113	0.138 528	0.034 632 0
1 cubic foot =	459 603.1	7660.052	957.506 5	239.376 6	59.844 16

Units	Liquid quarts	Gallons	Milliliters	Liters	Cubic inches	Cubic feet
1 minim =	0.000 065 104	0.000 016 276	0.061 610 2	0.000 061 610 2	0.003 759 77	0.000 002 175 79
1 fluid dram =	**0.003 906 25**	0.000 976 562	3.696 61	0.003 696 61	0.225 586	0.000 130 547
1 fluid ounce =	**0.031 25**	**0.007 812 5**	29.5729	0.029 572 9	1.804 69	0.001 044 38
1 gill =	**0.125**	**0.031 25**	118.292	0.118 292	**7.218 75**	0.004 177 52
1 liquid pint =	**0.5**	**0.125**	473.166	0.473 166	**28.875**	0.016 710 1
1 liquid quart =	**1**	**0.25**	946.332	0.946 332	**57.75**	0.033 420 1
1 gallon =	**4**	**1**	3785.329	3.785 329	**231**	0.133 680 6
1 milliliter =	0.001 056 71	0.000 264 178	**1**	**0.001**	0.061 025 1	0.000 035 315 4
1 liter =	1.056 71	0.264 178	**1000**	**1**	61.025 1	0.035 315 4
1 cubic inch =	0.017 316 0	0.004 329 00	16.3867	0.016 386 7	**1**	0.000 578 703 7
1 cubic foot. =	29.922 08	7.480 519 5	28 316.22	28.316 22	**1728**	**1**

UNITS OF VOLUME

Units	Cubic inches	Cubic feet	Cubic yards
1 cubic inch –	1	0.000 578 704	0.000 021 433 47
1 cubic foot –	1728	1	0.037 037 0
1 cubic yard –	46 656	27	1
1 cubic centimeter –	0.061 023 38	0.000 035 314 45	0.000 001 307 94
1 cubic decimeter –	61.023 38	0.035 314 45	0.001 307 943
1 cubic meter –	61 023.38	35.314 45	1.307 942 1

Units	Cubic centimeters	Cubic decimeters	Cubic meters
1 cubic inch –	16.387 162	0.016 387 16	0.000 016 387 16
1 cubic foot –	28 317.016	28.317 016	0.028 317 016
1 cubic yard –	764 559.4	764.5594	0.764 559 4
1 cubic centimeter –	1	0.001	0.000 001
1 cubic decimeter –	1 000	1	0.001
1 cubic meter –	1 000 000	1000	1

See Reference No. 3

EQUIVALENTS OF VOLUME

1 cubic centimeter (cm.^{3})
= 0.999972 ml.
= 0.0610237 in.^{3}
= 0.0338140 U. S. fl. oz.
1 cubic meter (m.^{3}) or stere (s.)
= 10^6 cm.^{3}
= 999.972 l.
= 35.3147 ft.^{3}
= 264.172 U. S. gal.
= 219.97 Brit. gal.
1 milliliter (ml.)
= 1.000028 cm.^{3}
= 0.0610255 in.^{3}
= 0.033815 U. S. fl. oz.
= 0.035196 Brit. fl. oz.
1 liter (l.)
(1 liter is defined as the volume occupied by 1 kilogram of water at its temperature of maximum density.)
= 1000.028 cm.^{3}
= 61.0255 in.^{3}
= 33.815 U. S. fl. oz.
= 1.05672 U. S. qt.
= 0.264179 U. S. gal.
= 35.196 Brit. fl. oz.
1 cubic inch (in.^{3})
= 0.554113 U. S. fl. oz.
= 16.3871 cm.^{3}
= 16.3866 ml.
1 cubic foot (ft.^{3})
= 1728 in.^{3}
= 29.9221 U. S. qt.
= 7.48052 U. S. gal.
= 28316.8 cm.^{3}
= 28.3161 l.

1 fluid ounce, U. S. (U. S. fl. oz.)
= 1.80469 in.^{3}
= 29.5735 cm.^{3}
= 29.5727 ml.
= 1.0408 Brit. fl. oz.
1 fluid ounce, British (Brit. fl. oz.)
= 1.7339 in.^{3}
= 28.413 cm.^{3}
= 28.412 ml.
= 0.96076 U. S. fl. oz.
1 quart, liquid, U. S. (U. S. qt.)
= 57.75 in.^{3}
= 32 U. S. fl. oz.
= 946.353 cm.^{3}
= 0.946326 l.
1 gallon, U. S. (U. S. gal.)
= 231 in.^{3}
= 128 U. S. fl. oz.
= 133.23 Brit. fl. oz.
= 0.83267 Brit. gal.
= 3785.41 cm.^{3}
= 3.78531 l.
1 gallon, British (Brit. gal.) (Imperial gallon)
(1 British gallon is defined as the volume occupied by 10 pounds of water at 62° F.)
= 160 Brit. fl. oz.
= 277.42 in.^{3}
= 1.2010 U. S. gal.
= 153.72 U. S. fl. oz.
= 4546.1 cm.^{3}
= 4.5460 l.

See Reference No. 17

CONVERSION FACTORS – VOLUME

Desired Units / Given Units	Cubic Yard	Cubic Foot	Cubic Inch	Cubic Meter	Cubic Decimeter	Cubic Centimeter	Liter
Cubic Yard	1	27	4.6656×10^{4}	0.764559	764.559	7.64559×10^{5}	764.54
Cubic Foot	3.7037×10^{-2}	1	1728	2.8317×10^{-2}	28.317	2.8317×10^{4}	28.316
Cubic Inch	2.143347×10^{-5}	5.78704×10^{-4}	1	1.63872×10^{-5}	1.63872×10^{-2}	16.3872	1.63868×10^{-2}
Cubic Meter	1.30794	35.314445	6.1023×10^{4}	1	1000	1×10^{6}	999.973
Cubic Decimeter	1.3079×10^{-3}	3.5314×10^{-2}	61.023	0.001	1	1000	.99997
Cubic Centimeter	1.3079×10^{-6}	3.5314×10^{-5}	6.1023×10^{-2}	1×10^{-6}	1×10^{-3}	1	9.99973×10^{-4}
Liter	1.3080×10^{-3}	3.5316×10^{-2}	61.025	1.000027×10^{-3}	1.000027	1000.027	1

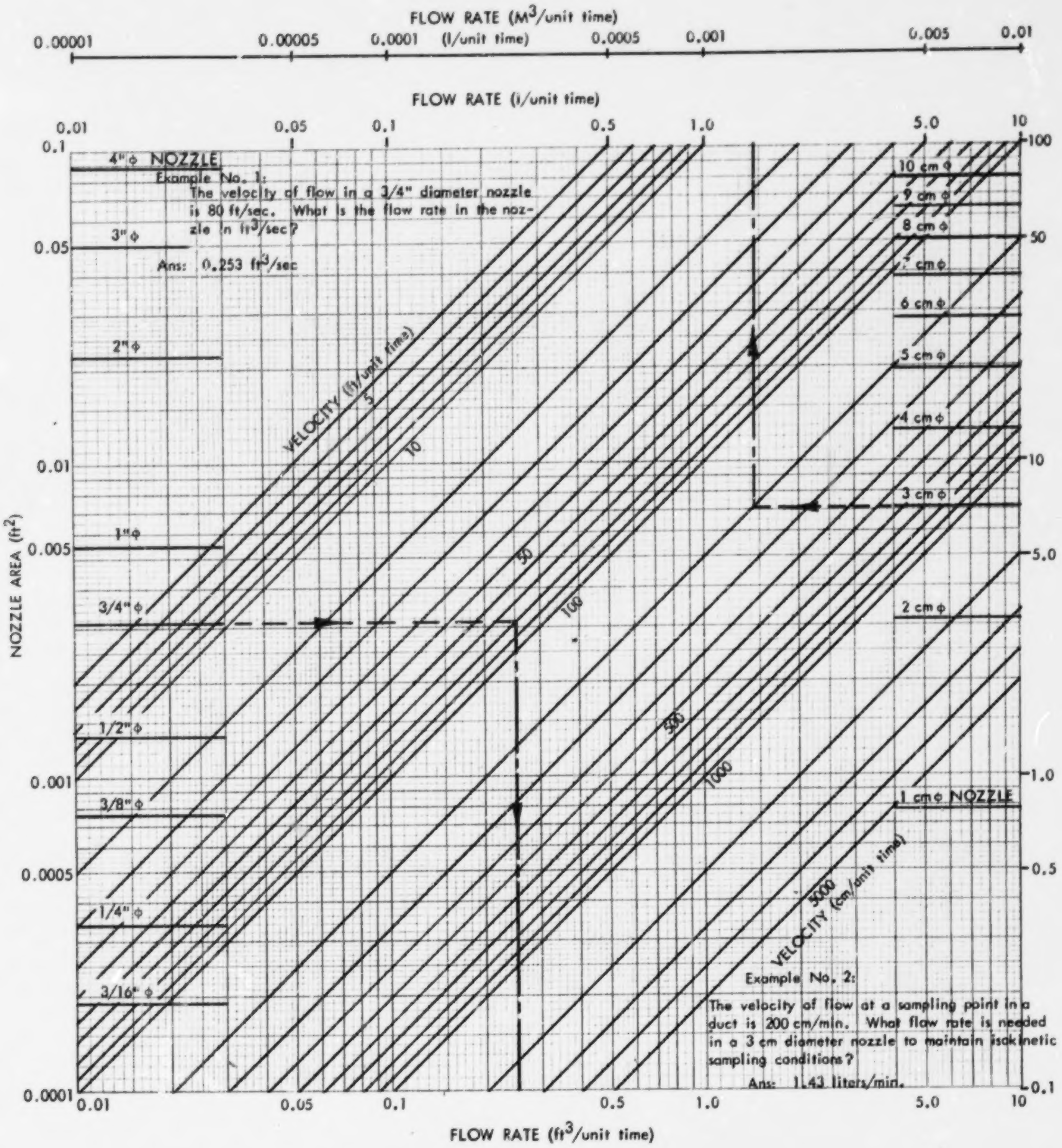
To convert a value from a given unit to a desired unit, multiply the given value by the factor opposite the given units and beneath the desired units.

CONVERSION FACTORS – FLOW

Desired Units / Given Units	$\frac{M^3}{sec}$	$\frac{M^3}{min}$	$\frac{M^3}{hour}$	$\frac{ft^3}{sec}$	$\frac{ft^3}{min}$	$\frac{ft^3}{hour}$	$\frac{L}{sec}$	$\frac{L}{min}$	$\frac{cm^3}{sec}$	$\frac{cm^3}{min}$
$\frac{M^3}{sec}$	1	60	3600	35.3144	21.1887×10^{2}	12.7132×10^{4}	999.973	59.998×10^{3}	1×10^{6}	6×10^{7}
$\frac{M^3}{min}$	0.0167	1	60	0.5886	35.3144	21.189×10^{2}	16.667	999.973	16.667×10^{3}	1×10^{6}
$\frac{M^3}{hour}$	2.778×10^{-5}	16.667×10^{-3}	1	98.90×10^{-4}	0.5886	35.3144	27.777×10^{-2}	16.667	2.777×10^{2}	1.666×10^{4}
$\frac{ft^3}{sec}$	28.317×10^{-3}	1.699	101.94	1	60	3600	28.316	16.9896×10^{2}	2.8317×10^{4}	1.699×10^{6}
$\frac{ft^3}{min}$	4.7195×10^{-4}	28.317×10^{-3}	1.699	16.667×10^{-3}	1	60	47.193×10^{-2}	28.316	4.7195×10^{2}	2.8317
$\frac{ft^3}{hour}$	7.8658×10^{-6}	4.7195×10^{-4}	28.317×10^{-3}	2.778×10^{-4}	16.667×10^{-3}	1	7.866×10^{-3}	0.4719	78.658	4.7195×10^{2}
$\frac{L}{sec}$	1.000027×10^{-3}	6.00016×10^{-2}	3.6	35.316×10^{-3}	2.11896	127.138	1	60	1000.027	16.667
$\frac{L}{min}$	1.6667×10^{-5}	1.000027×10^{-3}	6.00016×10^{-2}	5.886×10^{-4}	35.316×10^{-3}	2.11896	1.6667×10^{-2}	1	16.667	1000.027
$\frac{cm^3}{sec}$	1×10^{-6}	6×10^{-5}	3.6×10^{-3}	3.5314×10^{-5}	2.1189×10^{-3}	1.271×10^{-3}	9.99973×10^{-4}	5.9998×10^{-2}	1	16.667×10^{-3}
$\frac{cm^3}{min}$	1.6667×10^{-8}	1×10^{-6}	6×10^{-5}	5.886×10^{-7}	0.3531×10^{-4}	2.11887×10^{-3}	5.9998×10^{-2}	9.99973×10^{-4}	60	1

To convert a value from a given unit to a desired unit, multiply the given value by the factor opposite the given units and beneath the desired unit.

RELATIONSHIP BETWEEN NOZZLE SIZE AND FLOW RATE



Example No. 1:
The velocity of flow in a 3/4" diameter nozzle is 80 ft/sec. What is the flow rate in the nozzle in ft^3/sec?

Ans: 0.253 ft^3/sec

Example No. 2:
The velocity of flow at a sampling point in a duct is 200 cm/min. What flow rate is needed in a 3 cm diameter nozzle to maintain isokinetic sampling conditions?

Ans: 1.43 liters/min.

SECTION 8 MASS

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INTERNATIONAL ATOMIC WEIGHTS

BASED ON CARBON - 12

	Symbol	Atomic Number	Atomic Weight		Symbol	Atomic Number	Atomic Weight
Actinium	Ac	89	[227] *	Mercury	Hg	80	200.59
Aluminum	Al	13	26.9815	Molybdenum	Mo	42	95.94
Americium	Am	95	[243] *	Neodymium	Nd	60	144.24
Antimony	Sb	51	121.75	Neon	Ne	10	20.183
Argon	Ar	18	39.948	Neptunium	Np	93	[237] *
Arsenic	As	33	74.9216	Nickel	Ni	28	58.71
Astatine	At	85	[210] *	Niobium	Nb	41	92.906
Barium	Ba	56	137.34	Nitrogen	N	7	14.0067
Berkelium	Bk	97	[249] *	Nobelium	No	102	[254] *
Beryllium	Be	4	9.0122	Osmium	Os	76	190.2
Bismuth	Bi	83	208.980	Oxygen	O	8	15.9994 [a]
Boron	B	5	10.811 [a]	Palladium	Pd	46	106.4
Bromine	Br	35	79.909 [b]	Phosphorus	P	15	30.9738
Cadmium	Cd	48	112.40	Platinum	Pt	78	195.09
Calcium	Ca	20	40.08	Plutonium	Pu	94	[242] *
Californium	Cf	98	[251] *	Polonium	Po	84	[210] *
Carbon	C	6	12.01115 [a]	Potassium	K	19	39.102
Cerium	Ce	58	140.12	Praseodymium	Pr	59	140.907
Cesium	Cs	55	132.905	Promethium	Pm	61	[147] *
Chlorine	Cl	17	35.453 [b]	Protactinium	Pa	91	[231] *
Chromium	Cr	24	51.996 [b]	Radium	Ra	88	[226] *
Cobalt	Co	27	58.9332	Radon	Rn	86	[222] *
Copper	Cu	29	63.54	Rhenium	Re	75	186.2
Curium	Cm	96	[247] *	Rhodium	Rh	45	102.905
Dysprosium	Dy	66	162.50	Rubidium	Rb	37	85.47
Einsteinium	Es	99	[254] *	Ruthenium	Ru	44	101.07
Erbium	Er	68	167.26	Samarium	Sm	62	150.35
Europium	Eu	63	151.96	Scandium	Sc	21	44.956
Fermium	Fm	100	[253] *	Selenium	Se	34	78.96
Fluorine	F	9	18.9984	Silicon	Si	14	28.086 [a]
Francium	Fr	87	[223] *	Silver	Ag	47	107.870 [b]
Gadolinium	Gd	64	157.25	Sodium	Na	11	22.9898
Gallium	Ga	31	69.72	Strontium	Sr	38	87.62
Germanium	Ge	32	72.59	Sulfur	S	16	32.064 [a]
Gold	Au	79	196.967	Tantalum	Ta	73	180.948
Hafnium	Hf	72	178.49	Technetium	Tc	43	[99] *
Helium	He	2	4.0026	Tellurium	Te	52	127.60
Holmium	Ho	67	164.930	Terbium	Tb	65	158.924
Hydrogen	H	1	1.00797 [a]	Thallium	Tl	81	204.37
Indium	In	49	114.82	Thorium	Th	90	232.038
Iodine	I	53	126.9044	Thulium	Tm	69	168.934
Iridium	Ir	77	192.2	Tin	Sn	50	118.69
Iron	Fe	26	55.847 [b]	Titanium	Ti	22	47.90
Krypton	Kr	36	83.80	Tungsten	W	74	183.85
Lanthanum	La	57	138.91	Uranium	U	92	238.03
Lead	Pb	82	207.19	Vanadium	V	23	50.942
Lithium	Li	3	6.939	Xenon	Xe	54	131.30
Lutetium	Lu	71	174.97	Ytterbium	Yb	70	173.04
Magnesium	Mg	12	24.312	Yttrium	Y	39	88.905
Manganese	Mn	25	54.9380	Zinc	Zn	30	65.37
Mendelevium	Md	101	[256] *	Zirconium	Zr	40	91.22

* Value in brackets denotes the mass number of the isotope of longest known half life (or a better known one for Bk, Cf, Po, Pm, and Tc).

[a] Atomic weight varies because of natural variation in isotopic composition: B, ±0.003; C, ±0.00005; H, ±0.00001; O, ±0.0001; Si, ±0.001; S, ±0.003.

[b] Atomic weight is believed to have following experimental uncertainty: Br, ±0.002; Cl, ±0.001; Cr, ±0.001; Fe, ±0.003; Ag, ±0.003. For other elements, the last digit given for the atomic weight is believed reliable to ±0.5. Lawrencium, Lw, has been proposed as the name for element No. 103, nuclidic mass about 257.

See Reference No. 10

EQUIVALENTS OF WEIGHTS OR MASSES

1 assay ton [a] (AT)	29.167 grams.
1 carat (c)	200 milligrams. 3.086 grains.
1 dram, apothecaries (dr ap or ƒʒ)	60 grains. 3.888 grams.
1 dram, avoirdupois (dr avdp)	$27\frac{11}{32}$ (=27.344) grains. 1.772 grams.
gamma, *see* microgram.	
1 grain	64.799 milligrams.
1 gram (g)	15.432 grains. 0.035 ounce, avoirdupois.
1 hundredweight, gross or long [b] (gross cwt)	112 pounds. 50.802 kilograms.
1 hundredweight, net or short (cwt or net cwt)	100 pounds. 45.359 kilograms.
1 kilogram (kg)	2.205 pounds.
1 microgram (μg [the Greek letter mu in combination with the letter g])[c]	0.000 001 gram (exactly).
1 milligram (mg)	0.015 grain.
1 ounce, avoirdupois (oz avdp)	437.5 grains (exactly). 0.911 troy or apothecaries ounce. 28.350 grams.
1 ounce, troy or apothecaries (oz t or oz ap or ƒ℥)	480 grains. 1.097 avoirdupois ounces. 31.103 grams.
1 pennyweight (dwt)	1.555 grams.
1 point	0.01 carat. 2 milligrams.
1 pound, avoirdupois (lb avdp)	7 000 grains. 1.215 troy or apothecaries pounds. 453.592 grams.
1 pound, troy or apothecaries (lb t or lb ap)	5 760 grains. 0.823 avoirdupois pound. 373.242 grams.
1 scruple (s ap or ℈)	20 grains. 1.296 grams.
1 ton, gross or long [d]	2 240 pounds. 1.12 net tons (exactly). 1.016 metric tons.
1 ton, metric (t)	2 204.622 pounds. 0.984 gross ton. 1.102 net tons.
1 ton, net or short	2 000 pounds. 0.893 gross ton. 0.907 metric ton.

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[a] Used in assaying. The assay ton bears the same relation to the milligram that a ton of 2 000 pounds avoirdupois bears to the ounce troy; hence the weight in milligrams of precious metal obtained from one assay ton of ore gives directly the number of troy ounces to the net ton.

[b] The gross or long ton and hundredweight are used commercially in the United States to only a very limited extent, usually in restricted industrial fields. These units are the same as the British "ton" and "hundredweight."

[c] The symbol γ [the Greek letter gamma] is also used.

[d] The gross or long ton and hundredweight are used commercially in the United States to a limited extent only, usually in restricted industrial fields. These units are the same as the British "ton" and "hundredweight."

EQUIVALENTS OF WEIGHTS OR MASSES

(continued)

1 gram (g.)
= 15.4324 gr.
= 0.0352740 oz.
= 0.002204623 lb.
1 kilogram (kg.)
= 10^3 g.
= 35.2740 oz.
= 2.204623 lb.
1 metric ton, tonne (t.)
= 10^3 kg.
= 2204.623 lb.
= 1.10231 short tons
= 0.9842107 long ton

1 grain (gr.)
= 0.0647989 g.
= 0.00228571 oz.
1 ounce avoirdupois (oz.)
= 437.5 gr.
= 28.3495 g.
1 pound avoirdupois (lb.)
= 7000 gr.
= 16 oz.
= 453.5923 g.
= 0.4535923 kg.
1 short ton
= 2000 lb.
= 0.892857 long ton
= 907.1846 kg.
= 0.9071846 t.
1 long ton
= 2240 lb.
= 1.12 short tons
= 1016.047 kg.
= 1.016047 t.

See Reference No. 1

CONVERSION FACTORS FOR UNITS OF MASS

UNITS OF MASS LESS THAN POUNDS AND KILOGRAMS

Units	Grains	Apothecaries' scruples	Pennyweights	Avoirdupois drams
1 grain =	1	0.05	0.041 666 67	0.036 571 43
1 apoth. scruple =	20	1	0.833 333 3	0.731 428 6
1 pennyweight =	24	1.2	1	0.877 714 3
1 avoir. dram =	27.343 75	1.367 187 5	1.139 323	1
1 apoth. dram =	60	3	2.5	2.194 286
1 avoir. ounce =	437.5	21.875	18.229 17	16
1 apoth. or troy ounce =	480	24	20	17.554 28
1 apoth. or troy pound =	5760	288	240	210.6514
1 avoir. pound =	7000	350	291.6667	256
1 milligram =	0.015 432 356	0.000 771 618	0.000 643 014 8	0.000 564 383 3
1 gram =	15.432 356	0.771 618	0.643 014 85	0.564 383 3
1 kilogram =	15 432.356	771.6178	643.014 85	564.383 32

Units	Apothecaries' drams	Avoirdupois ounces	Apothecaries' or troy ounces	Apothecaries' or troy pounds
1 grain =	0.016 666 7	0.002 285 71	0.002 083 33	0.000 173 611 1
1 apoth. scruple =	0.333 333	0.045 714 3	0.041 666 7	0.003 472 222
1 pennyweight =	0.4	0.054 857.1	0.05	0.004 166 667
1 avoir. dram =	0.455 729 2	0.0625	0.056 966 146	0.004 747 178 8
1 apoth. dram =	1	0.137 142 9	0.125	0.010 416 667
1 avoir. ounce =	7.291 66	1	0.911 458 3	0.075 954 861
1 apoth. or troy ounce =	8	1.097 142 9	1	0.083 333 33
1 apoth. or troy pound =	96	13.165 714	12	1
1 avoir. pound =	116.6667	16	14.583 333	1.215 277 8
1 milligram =	0.000 257 205 9	0.000 035 273 96	0.000 032 150 74	0.000 002 679 23
1 gram =	0.257 205 9	0.035 273 96	0.032 150 74	0.002 679 23
1 kilogram =	257.205 94	35.273 96	32.150 742	2.679 228 5

Units	Avoirdupois pounds	Milligrams	Grams	Kilograms
1 grain =	0.000 142 857 1	64.798 918	0.064 798 918	0.000 064 798 9
1 apoth. scruple =	0.002 857 143	1295.9784	1.295 978 4	0.001 295 978
1 pennyweight =	0.003 428 571	1555.1740	1.555 174 0	0.001 555 174
1 avoir. dram =	0.003 906 25	1771.8454	1.771 845 4	0.001 771 845
1 apoth. dram =	0.008 571 429	3887.9351	3.887 935 1	0.003 887 935
1 avoir. ounce =	0.0625	28 349.527	28.349 527	0.028 349.53
1 apoth. or troy ounce =	0.068 571 43	31 103.481	31.103 481	0.031 103 48
1 apoth. or troy pound =	0.822 857.1	373 241.77	373.241 77	0.373 241 77
1 avoir. pound =	1	453 592.4277	453.592 427 7	0.453 592 427 7
1 milligram =	0.000 002 204 62	1	0.001	0.000 001
1 gram =	0.002 204 62	1000	1	0.001
1 kilogram =	2.204 622 341	1 000 000	1000	1

UNITS OF MASS GREATER THAN AVOIRDUPOIS OUNCES

Units	Avoirdupois ounces	Avoirdupois pounds	Short hundredweights	Short tons
1 avoirdupois ounce =	1	0.0625	0.000 625	0.000 031 25
1 avoirdupois pound =	16	1	0.01	0.0005
1 short hundredweight =	1600	100	1	0.05
1 short ton =	32 000	2000	20	1
1 long ton =	35 840	2240	22.4	1.12
1 kilogram =	35.273 957	2.204 622 34	0.022 046 223	0.001 102 311 2
1 metric ton =	35 273.957	2204.622 34	22.046 223	1.102 311 2

Units	Long tons	Kilograms	Metric tons
1 avoirdupois ounce =	0.000 027 901 79	0.028 349 53	0.000 028 349 53
1 avoirdupois pound =	0.000 446 428 6	0.453 592 427 7	0.000 453 592 43
1 short hundredweight =	0.044 642 86	45.359 243	0.045 359 243
1 short ton =	0.892 857 1	907.184 86	0.907 184 86
1 long ton =	1	1016.047 04	1.016 047 04
1 kilogram =	0.000 984 206 4	1	0.001
1 metric ton =	0.984 206 40	1000	1

See Reference No. 3

POUNDS AND OUNCES TO KILOGRAMS

1 avoirdupois pound = 0.4535923 kilogram
1 avoirdupois ounce = 0.0283495 kilogram

Pounds	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
	kg.	kg.	kg.	kg.	kg.	kg.	kg.	kg.	kg.	kg.
0	0.0000	0.0454	0.0907	0.1361	0.1814	0.2268	0.2722	0.3175	0.3629	0.4082
1	0.4536	0.4990	0.5443	0.5897	0.6350	0.6804	0.7257	0.7711	0.8165	0.8618
2	0.9072	0.9525	0.9979	1.0433	1.0886	1.1340	1.1793	1.2247	1.2701	1.3154
3	1.3608	1.4061	1.4515	1.4969	1.5422	1.5876	1.6329	1.6783	1.7237	1.7690
4	1.8144	1.8597	1.9051	1.9504	1.9958	2.0412	2.0865	2.1319	2.1772	2.2226
5	2.2680	2.3133	2.3587	2.4040	2.4494	2.4948	2.5401	2.5855	2.6308	2.6762
6	2.7216	2.7669	2.8123	2.8576	2.9030	2.9483	2.9937	3.0391	3.0844	3.1298
7	3.1751	3.2205	3.2659	3.3112	3.3566	3.4019	3.4473	3.4927	3.5380	3.5834
8	3.6287	3.6741	3.7195	3.7648	3.8102	3.8555	3.9009	3.9463	3.9916	4.0370
9	4.0823	4.1277	4.1730	4.2184	4.2638	4.3091	4.3545	4.3998	4.4452	4.4906

Ounces	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
	kg.	kg.	kg.	kg.	kg.	kg.	kg.	kg.	kg.	kg.
0	0.0000	0.0028	0.0057	0.0085	0.0113	0.0142	0.0170	0.0198	0.0227	0.0255
1	.0283	.0312	.0340	.0369	.0397	.0425	.0454	.0482	.0510	.0539
2	.0567	0595	.0624	.0652	.0680	.0709	.0737	.0765	.0794	.0822
3	.0850	.0879	.0907	.0936	.0964	.0992	.1021	.1049	.1077	.1106
4	.1134	.1162	.1191	.1219	.1247	.1276	.1304	.1332	.1361	.1389
5	0.1417	0.1446	0.1474	0.1503	0.1531	0.1559	0.1588	0.1616	0.1644	0.1673
6	.1701	.1729	.1758	.1786	.1814	.1843	.1871	.1899	.1928	.1956
7	.1984	.2013	.2041	.2070	.2098	.2126	.2155	.2183	.2211	.2240
8	.2268	.2296	.2325	.2353	.2381	.2410	.2438	.2466	.2495	.2523
9	.2551	.2580	.2608	.2637	.2665	.2693	.2722	.2750	.2778	.2807
10	0.2835	0.2863	0.2892	0.2920	0.2948	0.2977	0.3005	0.3033	0.3062	0.3090
11	.3118	.3147	.3175	.3203	.3232	.3260	.3289	.3317	.3345	.3374
12	.3402	.3430	.3459	.3487	.3515	.3544	.3572	.3600	.3629	.3657
13	.3685	.3714	.3742	.3770	.3799	.3827	.3856	.3884	.3912	.3941
14	.3969	.3997	.4026	.4054	.4082	.4111	.4139	.4167	.4196	.4224
15	0.4252	0.4281	0.4309	0.4337	0.4366	0.4394	0.4423	0.4451	0.4479	0.4508

KILOGRAMS TO AVOIRDUPOIS POUNDS AND OUNCES

1 kilogram = 2.204623 avoirdupois pounds

Kilograms	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	av. lbs.	av. lbs.	av. lbs.	av. lbs.	av. lbs.	av. lbs.	av. lbs.	av. lbs.	av. lbs.	av. lbs.
0	0.000	0.220	0.441	0.661	0.882	1.102	1.323	1.543	1.764	1.984
1	2.205	2.425	2.646	2.866	3.086	3.307	3.527	3.748	3.968	4.189
2	4.409	4.630	4.850	5.071	5.291	5.512	5.732	5.952	6.173	6.393
3	6.614	6.834	7.055	7.275	7.496	7.716	7.937	8.157	8.378	8.598
4	8.818	9.039	9.259	9.480	9.700	9.921	10.141	10.362	10.582	10.803
5	11.023	11.244	11.464	11.685	11.905	12.125	12.346	12.566	12.787	13.007
6	13.228	13.448	13.669	13.889	14.110	14.330	14.551	14.771	14.991	15.212
7	15.432	15.653	15.873	16.094	16.314	16.535	16.755	16.976	17.196	17.417
8	17.637	17.857	18.078	18.298	18.519	18.739	18.960	19.180	19.401	19.621
9	19.842	20.062	20.283	20.503	20.723	20.944	21.164	21.385	21.605	21.826

Tenths of a kilogram to ounces

kg.	oz.	kg.	oz.
0.1	3.5274	0.6	21.1644
.2	7.0548	.7	24.6918
.3	10.5822	.8	28.2192
.4	14.1096	.9	31.7466
.5	17.6370	1.0	35.2740

Hundredths of a kilogram to decimals of a pound and to ounces

kg.	av. lbs.		oz.	kg.	av. lbs.		oz.
0.01	0.022	=	0.35	0.06	0.132	=	2.12
.02	.044	=	0.71	.07	.154	=	2.47
.03	.066	=	1.06	.08	.176	=	2.82
.04	.088	=	1.41	.09	.198	=	3.17
.05	.110	=	1.76	.10	.220	=	3.53

See Reference No. 1

GRAMS TO GRAINS

1 gram = 15.432361 grains

Grams	.0 grains	.1 grains	.2 grains	.3 grains	.4 grains	.5 grains	.6 grains	.7 grains	.8 grains	.9 grains
0	0.00	1.54	3.09	4.63	6.17	7.72	9.26	10.80	12.35	13.89
1	15.43	16.98	18.52	20.06	21.61	23.15	24.69	26.24	27.78	29.32
2	30.86	32.41	33.95	35.49	37.04	38.58	40.12	41.67	43.21	44.75
3	46.30	47.84	49.38	50.93	52.47	54.01	55.56	57.10	58.64	60.19
4	61.73	63.27	64.82	66.36	67.90	69.45	70.99	72.53	74.08	75.62
5	77.16	78.71	80.25	81.79	83.33	84.88	86.42	87.96	89.51	91.05
6	92.59	94.14	95.68	97.22	98.77	100.31	101.85	103.40	104.94	106.48
7	108.03	109.57	111.11	112.66	114.20	115.74	117.29	118.83	120.37	121.92
8	123.46	125.00	126.55	128.09	129.63	131.18	132.72	134.26	135.80	137.35
9	138.89	140.43	141.98	143.52	145.06	146.61	148.15	149.69	151.24	152.78

	0 grains	1 grains	2 grains	3 grains	4 grains	5 grains	6 grains	7 grains	8 grains	9 grains
0	0.00	15.43	30.86	46.30	61.73	77.16	92.59	108.03	123.46	138.89
10	154.32	169.76	185.19	200.62	216.05	231.49	246.92	262.35	277.78	293.21
20	308.65	324.08	339.51	354.94	370.38	385.81	401.24	416.67	432.11	447.54
30	462.97	478.40	493.84	509.27	524.70	540.13	555.56	571.00	586.43	601.86
40	617.29	632.73	648.16	663.59	679.02	694.46	709.89	725.32	740.75	756.19
50	771.62	787.05	802.48	817.92	833.35	848.78	864.21	879.64	895.08	910.51
60	925.94	941.37	956.81	972.24	987.67	1003.10	1018.54	1033.97	1049.40	1064.83
70	1080.27	1095.70	1111.13	1126.56	1141.99	1157.43	1172.86	1188.29	1203.72	1219.16
80	1234.59	1250.02	1265.45	1280.89	1296.32	1311.75	1327.18	1342.62	1358.05	1373.48
90	1388.91	1404.34	1419.78	1435.21	1450.64	1466.07	1481.51	1496.94	1512.37	1527.80

gram	grain	gram	grain	gram	grain	gram	grain
0.01	0.154	0.06	0.926	0.001	0.015	0.006	0.093
.02	.309	.07	1.080	.002	.031	.007	.108
.03	.463	.08	1.235	.003	.046	.008	.123
.04	.617	.09	1.389	.004	.062	.009	.139
.05	.772	.10	1.543	.005	.077	.010	.154

GRAINS TO GRAMS

1 grain = 0.06479890 gram

Grains	0 grams	1 grams	2 grams	3 grams	4 grams	5 grams	6 grams	7 grams	8 grams	9 grams
0	0.0000	0.0648	0.1296	0.1944	0.2592	0.3240	0.3888	0.4536	0.5184	0.5832
10	0.6480	0.7128	0.7776	0.8424	0.9072	0.9720	1.0368	1.1016	1.1664	1.2312
20	1.2960	1.3608	1.4256	1.4904	1.5552	1.6200	1.6848	1.7496	1.8144	1.8792
30	1.9440	2.0088	2.0736	2.1384	2.2032	2.2680	2.3328	2.3976	2.4624	2.5272
40	2.5920	2.6568	2.7216	2.7864	2.8512	2.9160	2.9807	3.0455	3.1103	3.1751
50	3.2399	3.3047	3.3695	3.4343	3.4991	3.5639	3.6287	3.6935	3.7583	3.8231
60	3.8879	3.9527	4.0175	4.0823	4.1471	4.2119	4.2767	4.3415	4.4063	4.4711
70	4.5359	4.6007	4.6655	4.7303	4.7951	4.8599	4.9247	4.9895	5.0543	5.1191
80	5.1839	5.2487	5.3135	5.3783	5.4431	5.5079	5.5727	5.6375	5.7023	5.7671
90	5.8319	5.8967	5.9615	6.0263	6.0911	6.1559	6.2207	6.2855	6.3503	6.4151

Tenths of a grain				Hundredths of a grain			
grain	gram	grain	gram	grain	gram	grain	gram
0.1	0.0065	0.6	0.0389	0.01	0.0006	0.06	0.0039
.2	.0130	.7	.0454	.02	.0013	.07	.0045
.3	.0194	.8	.0518	.03	.0019	.08	.0052
.4	.0259	.9	.0583	.04	.0026	.09	.0058
.5	.0324	1.0	.0648	.05	.0032	.10	.0065

See Reference No. 1

COMPARISON OF THE VARIOUS TONS AND POUNDS IN USE IN THE UNITED STATES (FROM 1 TO 9 UNITS)

Troy pounds	Avoirdupois pounds	Kilograms	Short tons	Long tons	Metric tons
1	0.822 857	0.373 24	0.000 411 43	0.000 367 35	0.000 373 24
2	1.645 71	0.746 48	0.000 822 86	0.000 734 69	0.000 746 48
3	2.468 57	1.119 73	0.001 234 29	0.001 102 04	0.001 119 73
4	3.291 43	1.492 97	0.001 645 71	0.001 469 39	0.001 492 97
5	4.114 29	1.866 21	0.002 057 14	0.001 836 73	0.001 866 21
6	4.937 14	2.239 45	0.002 468 57	0.002 204 08	0.002 239 45
7	5.760 00	2.612 69	0.002 880 00	0.002 571 43	0.002 612 69
8	6.582 86	2.985 93	0.003 291 43	0.002 938 78	0.002 985 93
9	7.405 71	3.359 18	0.003 702 86	0.003 306 12	0.003 359 18
1.215 28	1	0.453 59	0.0005	0.000 446 43	0.000 453 59
2.430 56	2	0.907 18	0.0010	0.000 892 86	0.000 907 18
3.645 83	3	1.360 78	0.0015	0.001 339 29	0.001 360 78
4.861 11	4	1.814 37	0.0020	0.001 785 71	0.001 814 37
6.076 39	5	2.267 96	0.0025	0.002 232 14	0.002 267 96
7.291 67	6	2.721 55	0.0030	0.002 678 57	0.002 721 55
8.506 94	7	3.175 15	0.0035	0.003 125 00	0.003 175 15
9.722 22	8	3.628 74	0.0040	0.003 571 43	0.003 628 74
10.937 50	9	4.082 33	0.0045	0.004 017 86	0.004 082 33
2.679 23	2.204 62	1	0.001 102 31	0.000 984 21	0.001
5.358 46	4.409 24	2	0.002 204 62	0.001 968 41	0.002
8.037 69	6.613 87	3	0.003 306 93	0.002 952 62	0.003
10.716 91	8.818 49	4	0.004 409 24	0.003 936 83	0.004
13,937 50	11.023 11	5	0.005 511 56	0.004 921 03	0.005
16.075 37	13.227 73	6	0.006 613 87	0.005 905 24	0.006
18.754 60	15.432 36	7	0.007 716 18	0.006 889 44	0.007
21.433 83	17.636 98	8	0.008 818 49	0.007 873 65	0.008
24.113 06	19.841 60	9	0.009 920 80	0.008 857 86	0.009
2430.56	2000	907.18	1	0.892 87	0.907 18
4861.11	4000	1814.37	2	1.785 71	1.814 37
7291.67	6000	2721.55	3	2.678 57	2.721 55
9722.22	8000	3628.74	4	3.571 43	3.628 74
12 152.78	10 000	4535.92	5	4.464 29	4.535 92
14 583.33	12 000	5443.11	6	5.357 14	5.443 11
17 013.89	14 000	6350.29	7	6.250 00	6.350 29
19 444.44	16 000	7257.48	8	7.142 86	7.257 48
21 875.00	18 000	8164.66	9	8.035 71	8.164 66
2722.22	2240	1016.05	1.12	1	1.016 05
5444.44	4480	2032.09	2.24	2	2.032 09
8166.67	6720	3048.14	3.36	3	3.048 14
10 888.89	8960	4064.19	4.48	4	4.064 19
13 611.11	11 200	5080.24	5.60	5	5.080 24
16 333.33	13 440	6096.28	6.72	6	6.096 28
19 055.56	15 680	7112.32	7.84	7	7.112 32
21 777.78	17 920	8128.38	8.96	8	8.128 38
24 500.00	20 160	9144.42	10.08	9	9.144 42
2679.23	2204.62	1000	1.102 31	0.984 21	1
5358.48	4409.24	2000	2.204 62	1.968 41	2
8037.69	6613.87	3000	3.306 93	2.952 62	3
10 716.91	8818.49	4000	4.409 24	3.936 83	4
13 937.50	11 023.11	5000	5.511 56	4.921 03	5
16 075.37	13 227.73	6000	6.613 87	5.905 24	6
18 754.60	15 432.36	7000	7.716 18	6.889 44	7
21 433.83	17 636.98	8000	8.818 49	7.873 65	8
24 113.06	19 841.60	9000	9.920 80	8.857 86	9

See Reference No. 3

EQUIVALENTS IN KILOGRAMS OF 1 TO 999 AVOIRDUPOIS POUNDS

[Reduction factor: 1 avoirdupois pound=0.4535924277 kilogram]

Pounds	Kilos	Pounds	Kilos	Pounds	Kilos	Pounds	Kilos	Pounds	Kilos	Pounds	Kilos	Pounds	Kilos	Pounds	Kilos	Pounds	Kilos	Pounds	Kilos
0		100	45.35924	200	90.71849	300	136.07773	400	181.43697	500	226.79621	600	272.15546	700	317.51470	800	362.87394	900	408.23318
1	0.45359	1	45.81284	1	91.17208	1	136.53132	1	181.89056	1	227.24981	1	272.60905	1	317.96829	1	363.32753	1	408.68678
2	.90718	2	46.26643	2	91.62567	2	136.98491	2	182.34416	2	227.70340	2	273.06264	2	318.42188	2	363.78113	2	409.14037
3	1.36078	3	46.72002	3	92.07926	3	137.43851	3	182.79775	3	228.15699	3	273.51623	3	318.87548	3	364.23472	3	409.59396
4	1.81437	4	47.17361	4	92.53286	4	137.89210	4	183.25134	4	228.61058	4	273.96983	4	319.32907	4	364.68831	4	410.04755
5	2.26796	5	47.62720	5	92.98645	5	138.34569	5	183.70493	5	229.06418	5	274.42342	5	319.78266	5	365.14190	5	410.50115
6	2.72155	6	48.08080	6	93.44004	6	138.79928	6	184.15853	6	229.51777	6	274.87701	6	320.23625	6	365.59550	6	410.95474
7	3.17515	7	48.53439	7	93.89363	7	139.25288	7	184.61212	7	229.97136	7	275.33060	7	320.68985	7	366.04909	7	411.40833
8	3.62874	8	48.98798	8	94.34722	8	139.70647	8	185.06571	8	230.42495	8	275.78420	8	321.14344	8	366.50268	8	411.86192
9	4.08233	9	49.44157	9	94.80082	9	140.16006	9	185.51930	9	230.87855	9	276.23779	9	321.59703	9	366.95627	9	412.31552
10	4.53592	110	49.89517	210	95.25441	310	140.61365	410	185.97290	510	231.33214	610	276.69138	710	322.05062	810	367.40987	910	412.76911
1	4.98952	1	50.34876	1	95.70800	1	141.06725	1	186.42649	1	231.78573	1	277.14497	1	322.50422	1	367.86346	1	413.22270
2	5.44311	2	50.80235	2	96.16159	2	141.52084	2	186.88008	2	232.23932	2	277.59857	2	322.95781	2	368.31705	2	413.67629
3	5.89670	3	51.25594	3	96.61519	3	141.97443	3	187.33367	3	232.69292	3	278.05216	3	323.41140	3	368.77064	3	414.12989
4	6.35029	4	51.70954	4	97.06878	4	142.42802	4	187.78727	4	233.14651	4	278.50575	4	323.86499	4	369.22424	4	414.58348
5	6.80389	5	52.16313	5	97.52237	5	142.88161	5	188.24086	5	233.60010	5	278.95934	5	324.31859	5	369.67783	5	415.03707
6	7.25748	6	52.61672	6	97.97596	6	143.33521	6	188.69445	6	234.05369	6	279.41294	6	324.77218	6	370.13142	6	415.49066
7	7.71107	7	53.07031	7	98.42956	7	143.78880	7	189.14804	7	234.50729	7	279.86653	7	325.22577	7	370.58501	7	415.94426
8	8.16466	8	53.52391	8	98.88315	8	144.24239	8	189.60163	8	234.96088	8	280.32012	8	325.67936	8	371.03861	8	416.39785
9	8.61826	9	53.97750	9	99.33674	9	144.69598	9	190.05523	9	235.41447	9	280.77371	9	326.13296	9	371.49220	9	416.85144
20	9.07185	120	54.43109	220	99.79033	320	145.14958	420	190.50882	520	235.86806	620	281.22731	720	326.58655	820	371.94579	920	417.30503
1	9.52544	1	54.88468	1	100.24393	1	145.60317	1	190.96241	1	236.32165	1	281.68090	1	327.04014	1	372.39938	1	417.75863
2	9.97903	2	55.33828	2	100.69752	2	146.05676	2	191.41600	2	236.77525	2	282.13449	2	327.49373	2	372.85298	2	418.21222
3	10.43263	3	55.79187	3	101.15111	3	146.51035	3	191.86960	3	237.22884	3	282.58808	3	327.94733	3	373.30657	3	418.66581
4	10.88622	4	56.24546	4	101.60470	4	146.96395	4	192.32319	4	237.68243	4	283.04167	4	328.40092	4	373.76016	4	419.11940
5	11.33981	5	56.69905	5	102.05830	5	147.41754	5	192.77678	5	238.13602	5	283.49527	5	328.85451	5	374.21375	5	419.57300
6	11.79340	6	57.15265	6	102.51189	6	147.87113	6	193.23037	6	238.58962	6	283.94886	6	329.30810	6	374.66735	6	420.02659
7	12.24700	7	57.60624	7	102.96548	7	148.32472	7	193.68397	7	239.04321	7	284.40245	7	329.76169	7	375.12094	7	420.48018
8	12.70059	8	58.05983	8	103.41907	8	148.77832	8	194.13756	8	239.49680	8	284.85604	8	330.21529	8	375.57453	8	420.93377
9	13.15418	9	58.51342	9	103.87267	9	149.23191	9	194.59115	9	239.95039	9	285.30964	9	330.66888	9	376.02812	9	421.38737
30	13.60777	130	58.96702	230	104.32626	330	149.68550	430	195.04474	530	240.40399	630	285.76323	730	331.12247	830	376.48171	930	421.84096
1	14.06137	1	59.42061	1	104.77985	1	150.13909	1	195.49834	1	240.85758	1	286.21682	1	331.57606	1	376.93531	1	422.29455
2	14.51496	2	59.87420	2	105.23344	2	150.59269	2	195.95193	2	241.31117	2	286.67041	2	332.02966	2	377.38890	2	422.74814
3	14.96855	3	60.32779	3	105.68704	3	151.04628	3	196.40552	3	241.76476	3	287.12401	3	332.48325	3	377.84249	3	423.20174
4	15.42214	4	60.78139	4	106.14063	4	151.49987	4	196.85911	4	242.21836	4	287.57760	4	332.93684	4	378.29608	4	423.65533
5	15.87573	5	61.23498	5	106.59422	5	151.95346	5	197.31271	5	242.67195	5	288.03119	5	333.39043	5	378.74968	5	424.10892
6	16.32933	6	61.68857	6	107.04781	6	152.40706	6	197.76630	6	243.12554	6	288.48478	6	333.84403	6	379.20327	6	424.56251
7	16.78292	7	62.14216	7	107.50141	7	152.86065	7	198.21989	7	243.57913	7	288.93838	7	334.29762	7	379.65686	7	425.01610
8	17.23651	8	62.59576	8	107.95500	8	153.31424	8	198.67348	8	244.03273	8	289.39197	8	334.75121	8	380.11045	8	425.46970
9	17.69010	9	63.04935	9	108.40859	9	153.76783	9	199.12708	9	244.48632	9	289.84556	9	335.20480	9	380.56405	9	425.92329
40	18.14370	140	63.50294	240	108.86218	340	154.22143	440	199.58067	540	244.93991	640	290.29915	740	335.65840	840	381.01764	940	426.37688
1	18.59729	1	63.95653	1	109.31578	1	154.67502	1	200.03426	1	245.39350	1	290.75275	1	336.11199	1	381.47123	1	426.83047
2	19.05088	2	64.41012	2	109.76937	2	155.12861	2	200.48785	2	245.84710	2	291.20634	2	336.56558	2	381.92482	2	427.28407
3	19.50447	3	64.86372	3	110.22296	3	155.58220	3	200.94145	3	246.30069	3	291.65993	3	337.01917	3	382.37842	3	427.73766
4	19.95807	4	65.31731	4	110.67655	4	156.03580	4	201.39504	4	246.75428	4	292.11352	4	337.47277	4	382.83201	4	428.19125
5	20.41166	5	65.77090	5	111.13014	5	156.48939	5	201.84863	5	247.20787	5	292.56712	5	337.92636	5	383.28560	5	428.64484
6	20.86525	6	66.22449	6	111.58374	6	156.94298	6	202.30222	6	247.66147	6	293.02071	6	338.37995	6	383.73919	6	429.09844
7	21.31884	7	66.67809	7	112.03733	7	157.39657	7	202.75582	7	248.11506	7	293.47430	7	338.83354	7	384.19279	7	429.55203
8	21.77244	8	67.13168	8	112.49092	8	157.85016	8	203.20941	8	248.56865	8	293.92789	8	339.28714	8	384.64638	8	430.00562
9	22.22603	9	67.58527	9	112.94451	9	158.30376	9	203.66300	9	249.02224	9	294.38149	9	339.74073	9	385.09997	9	430.45921

See Reference No. 3

EQUIVALENTS IN KILOGRAMS OF 1 TO 999 AVOIRDUPOIS POUNDS

(continued)

50	22. 67962	**150**	68. 03886	**250**	113. 39811	**350**	158. 75735	**450**	204. 11659	**550**	249. 47584	**650**	294. 83508	**750**	340. 19432	**850**	385. 55356	**950**	430. 91281
1	23. 13321	1	68. 49246	1	113. 85170	1	159. 21094	1	204. 57018	1	249. 92943	1	295. 28867	1	340. 64791	1	386. 00716	1	431. 36640
2	23. 58681	2	68. 94605	2	114. 30529	2	159. 66453	2	205. 02378	2	250. 38302	2	295. 74226	2	341. 10151	2	386. 46075	2	431. 81999
3	24. 04040	3	69. 39964	3	114. 75888	3	160. 11813	3	205. 47737	3	250. 83661	3	296. 19586	3	341. 55510	3	386. 91434	3	432. 27358
4	24. 49399	4	69. 85323	4	115. 21248	4	160. 57172	4	205. 93096	4	251. 29021	4	296. 64945	4	342. 00869	4	387. 36793	4	432. 72718
5	24. 94758	5	70. 30683	5	115. 66607	5	161. 02531	5	206. 38455	5	251. 74380	5	297. 10304	5	342. 46228	5	387. 82153	5	433. 18077
6	25. 40118	6	70. 76042	6	116. 11966	6	161. 47890	6	206. 83815	6	252. 19739	6	297. 55663	6	342. 91588	6	388. 27512	6	433. 63436
7	25. 85477	7	71. 21401	7	116. 57325	7	161. 93250	7	207. 29174	7	252. 65098	7	298. 01022	7	343. 36947	7	388. 72871	7	434. 08795
8	26. 30836	8	71. 66760	8	117. 02685	8	162. 38609	8	207. 74533	8	253. 10457	8	298. 46382	8	343. 82306	8	389. 18230	8	434. 54155
9	26. 76195	9	72. 12120	9	117. 48044	9	162. 83968	9	208. 19892	9	253. 55817	9	298. 91741	9	344. 27665	9	389. 63590	9	434. 99514
60	27. 21555	**160**	72. 57479	**260**	117. 93403	**360**	163. 29327	**460**	208. 65252	**560**	254. 01176	**660**	299. 37100	**760**	344. 73025	**860**	390. 08949	**960**	435. 44873
1	27. 66914	1	73. 02838	1	118. 38762	1	163. 74687	1	209. 10611	1	254. 46535	1	299. 82459	1	345. 18384	1	390. 54308	1	435. 90232
2	28. 12273	2	73. 48197	2	118. 84122	2	164. 20046	2	209. 55970	2	254. 91894	2	300. 27819	2	345. 63743	2	390. 99667	2	436. 35592
3	28. 57632	3	73. 93557	3	119. 29481	3	164. 65405	3	210. 01329	3	255. 37254	3	300. 73178	3	346. 09102	3	391. 45027	3	436. 80951
4	29. 02992	4	74. 38916	4	119. 74840	4	165. 10764	4	210. 46689	4	255. 82613	4	301. 18537	4	346. 54461	4	391. 90386	4	437. 26310
5	29. 48351	5	74. 84275	5	120. 20199	5	165. 56124	5	210. 92048	5	256. 27972	5	301. 63896	5	346. 99821	5	392. 35745	5	437. 71669
6	29. 93710	6	75. 29634	6	120. 65559	6	166. 01483	6	211. 37407	6	256. 73331	6	302. 09256	6	347. 45180	6	392. 81104	6	438. 17029
7	30. 39069	7	75. 74994	7	121. 10918	7	166. 46842	7	211. 82766	7	257. 18691	7	302. 54615	7	347. 90539	7	393. 26463	7	438. 62388
8	30. 84429	8	76. 20353	8	121. 56277	8	166. 92201	8	212. 28126	8	257. 64050	8	302. 99974	8	348. 35898	8	393. 71823	8	439. 07747
9	31. 29788	9	76. 65712	9	122. 01636	9	167. 37561	9	212. 73485	9	258. 09409	9	303. 45333	9	348. 81258	9	394. 17182	9	439. 53106
70	31. 75147	**170**	77. 11071	**270**	122. 46996	**370**	167. 82920	**470**	213. 18844	**570**	258. 54768	**670**	303. 90693	**770**	349. 26617	**870**	394. 62541	**970**	439. 98465
1	32. 20506	1	77. 56431	1	122. 92355	1	168. 28279	1	213. 64203	1	259. 00128	1	304. 36052	1	349. 71976	1	395. 07900	1	440. 43825
2	32. 65865	2	78. 01790	2	123. 37714	2	168. 73638	2	214. 09563	2	259. 45487	2	304. 81411	2	350. 17335	2	395. 53260	2	440. 89184
3	33. 11225	3	78. 47149	3	123. 83073	3	169. 18998	3	214. 54922	3	259. 90846	3	305. 26770	3	350. 62695	3	395. 98619	3	441. 34543
4	33. 56584	4	78. 92509	4	124. 28433	4	169. 64357	4	215. 00281	4	260. 36205	4	305. 72130	4	351. 08054	4	396. 43978	4	441. 79902
5	34. 01943	5	79. 37867	5	124. 73792	5	170. 09716	5	215. 45640	5	260. 81565	5	306. 17489	5	351. 53413	5	396. 89337	5	442. 25262
6	34. 47302	6	79. 83227	6	125. 19151	6	170. 55075	6	215. 91000	6	261. 26924	6	306. 62848	6	351. 98772	6	397. 34697	6	442. 70621
7	34. 92662	7	80. 28586	7	125. 64510	7	171. 00435	7	216. 36359	7	261. 72283	7	307. 08207	7	352. 44132	7	397. 80056	7	443. 15980
8	35. 38021	8	80. 73945	8	126. 09869	8	171. 45794	8	216. 81718	8	262. 17642	8	307. 53567	8	352. 89491	8	398. 25415	8	443. 61339
9	35. 83380	9	81. 19304	9	126. 55229	9	171. 91153	9	217. 27077	9	262. 63002	9	307. 98926	9	353. 34850	9	398. 70774	9	444. 06699
80	36. 28739	**180**	81. 64664	**280**	127. 00588	**380**	172. 36512	**480**	217. 72437	**580**	263. 08361	**680**	308. 44285	**780**	353. 80209	**880**	399. 16134	**980**	444. 52058
1	36. 74099	1	82. 10023	1	127. 45947	1	172. 81871	1	218. 17796	1	263. 53720	1	308. 89644	1	354. 25569	1	399. 61493	1	444. 97417
2	37. 19458	2	82. 55382	2	127. 91306	2	173. 27231	2	218. 63155	2	263. 99079	2	309. 35004	2	354. 70928	2	400. 06852	2	445. 42776
3	37. 64817	3	83. 00741	3	128. 36666	3	173. 72590	3	219. 08514	3	264. 44439	3	309. 80363	3	355. 16287	3	400. 52211	3	445. 88136
4	38. 10176	4	83. 46101	4	128. 82025	4	174. 17949	4	219. 53874	4	264. 89798	4	310. 25722	4	355. 61646	4	400. 97571	4	446. 33495
5	38. 55536	5	83. 91460	5	129. 27384	5	174. 63308	5	219. 99233	5	265. 35157	5	310. 71081	5	356. 07006	5	401. 42930	5	446. 78854
6	39. 00895	6	84. 36819	6	129. 72743	6	175. 08668	6	220. 44592	6	265. 80516	6	311. 16441	6	356. 52365	6	401. 88289	6	447. 24213
7	39. 46254	7	84. 82178	7	130. 18103	7	175. 54027	7	220. 89951	7	266. 25876	7	311. 61800	7	356. 97724	7	402. 33648	7	447. 69573
8	39. 91613	8	85. 27538	8	130. 63462	8	175. 99386	8	221. 35310	8	266. 71235	8	312. 07159	8	357. 43083	8	402. 79008	8	448. 14932
9	40. 36973	9	85. 72897	9	131. 08821	9	176. 44745	9	221. 80670	9	267. 16594	9	312. 52518	9	357. 88443	9	403. 24367	9	448. 60291
90	40. 82332	**190**	86. 18256	**290**	131. 54180	**390**	176. 90105	**490**	222. 26029	**590**	267. 61953	**690**	312. 97878	**790**	358. 33802	**890**	403. 69726	**990**	449. 05650
1	41. 27691	1	86. 63615	1	131. 99540	1	177. 35464	1	222. 71388	1	268. 07312	1	313. 43237	1	358. 79161	1	404. 15085	1	449. 51010
2	41. 73050	2	87. 08975	2	132. 44899	2	177. 80823	2	223. 16747	2	268. 52672	2	313. 88596	2	359. 24520	2	404. 60445	2	449. 96369
3	42. 18410	3	87. 54334	3	132. 90258	3	178. 26182	3	223. 62107	3	268. 98031	3	314. 33955	3	359. 69880	3	405. 05804	3	450. 41728
4	42. 63769	4	87. 99693	4	133. 35617	4	178. 71542	4	224. 07466	4	269. 43390	4	314. 79314	4	360. 15239	4	405. 51163	4	450. 87087
5	43. 09128	5	88. 45052	5	133. 80977	5	179. 16901	5	224. 52825	5	269. 88749	5	315. 24674	5	360. 60598	5	405. 96522	5	451. 32447
6	43. 54487	6	88. 90412	6	134. 26336	6	179. 62260	6	224. 98184	6	270. 34109	6	315. 70033	6	361. 05957	6	406. 41882	6	451. 77806
7	43. 99847	7	89. 35771	7	134. 71695	7	180. 07619	7	225. 43544	7	270. 79468	7	316. 15392	7	361. 51316	7	406. 87241	7	452. 23165
8	44. 45206	8	89. 81130	8	135. 17054	8	180. 52979	8	225. 88903	8	271. 24827	8	316. 60751	8	361. 96676	8	407. 32600	8	452. 68524
9	44. 90565	9	90. 26489	9	135. 62414	9	180. 98338	9	226. 34262	9	271. 70186	9	317. 06111	9	362. 42035	9	407. 77959	9	453. 13884

EQUIVALENTS IN AVOIRDUPOIS POUNDS OF 1 TO 999 KILOGRAMS

[Reduction factor: 1 kilogram=2.204622341 avoirdupois pounds]

Kilos	Pounds	Kilos	Pounds	Kilos	Pounds	Kilos	Pounds	Kilos	Pounds	Kilos	Pounds	Kilos	Pounds	Kilos	Pounds	Kilos	Pounds	Kilos	Pounds
0		**100**	220.4622	**200**	440.9245	**300**	661.3867	**400**	881.8489	**500**	1,102.3112	**600**	1,322.7734	**700**	1,543.2356	**800**	1,763.6979	**900**	1,984.1601
1	2.2046	1	222.6669	1	443.1291	1	563.5913	1	884.0536	1	1,104.5158	1	1,324.9780	1	1,545.4403	1	1,765.9025	1	1,986.3647
2	4.4092	2	224.8715	2	445.3337	2	665.7959	2	886.2582	2	1,106.7204	2	1,327.1826	2	1,547.6449	2	1,768.1071	2	1,988.5694
3	6.6139	3	227.0761	3	447.5383	3	668.0006	3	888.4628	3	1,108.9250	3	1,329.3873	3	1,549.8495	3	1,770.3117	3	1,990.7740
4	8.8185	4	229.2807	4	449.7430	4	670.2052	4	890.6674	4	1,111.1297	4	1,331.5919	4	1,552.0541	4	1,172.5164	4	1,992.9786
5	11.0231	5	231.4853	5	451.9476	5	672.4098	5	892.8720	5	1,113.3343	5	1,333.7965	5	1,554.2588	5	1,774.7210	5	1,995.1832
6	13.2277	6	233.6900	6	454.1522	6	674.6144	6	895.0767	6	1,115.5389	6	1,336.0011	6	1,556.4634	6	1,776.9256	6	1,997.3878
7	15.4324	7	235.8946	7	456.3568	7	676.8191	7	897.2813	7	1,117.7435	7	1,338.2058	7	1,558.6680	7	1,779.1302	7	1,999.5925
8	17.6370	8	238.0992	8	458.5614	8	679.0237	8	899.4859	8	1,119.9481	8	1,340.4104	8	1,560.8726	8	1,781.3349	8	2,001.7971
9	19.8416	9	240.3038	9	460.7661	9	681.2283	9	901.6905	9	1,122.1528	9	1,342.6150	9	1,563.0772	9	1,783.5395	9	2,004.0017
10	22.0462	**110**	242.5085	**210**	462.9707	**310**	683.4329	**410**	903.8952	**510**	1,124.3574	**610**	1,344.8196	**710**	1,565.2819	**810**	1,785.7441	**910**	2,006.2063
1	24.2508	1	244.7131	1	465.1753	1	685.6375	1	906.0998	1	1,126.5620	1	1,347.0243	1	1,567.4865	1	1,787.9487	1	2,008.4110
2	26.4555	2	246.9177	2	467.3799	2	687.8422	2	908.3044	2	1,128.7666	2	1,349.2289	2	1,569.6911	2	1,790.1533	2	2,010.6156
3	28.6601	3	249.1223	3	469.5846	3	690.0468	3	910.5090	3	1,130.9713	3	1,351.4335	3	1,571.8957	3	1,792.3580	3	2,012.8202
4	30.8647	4	251.3269	4	471.7892	4	692.2514	4	912.7136	4	1,133.1759	4	1,353.6381	4	1,574.1004	4	1,794.5626	4	2,015.0248
5	33.0693	5	253.5316	5	473.9938	5	694.4560	5	914.9183	5	1,135.3805	5	1,355.8427	5	1,576.3050	5	1,796.7672	5	2,017.2294
6	35.2740	6	255.7362	6	476.1984	6	696.6607	6	917.1229	6	1,137.5851	6	1,358.0474	6	1,578.5096	6	1,798.9718	6	2,019.4341
7	37.4786	7	257.9408	7	478.4030	7	698.8653	7	919.3275	7	1,139.7898	7	1,360.2520	7	1,580.7142	7	1,801.1765	7	2,021.6387
8	39.6832	8	260.1454	8	480.6077	8	701.0699	8	921.5321	8	1,141.9944	8	1,362.4566	8	1,582.9188	8	1,803.3811	8	2,023.8433
9	41.8878	9	262.3501	9	482.8123	9	703.2745	9	923.7368	9	1,144.1990	9	1,364.6612	9	1,585.1235	9	1,805.5857	9	2,026.0479
20	44.0924	**120**	264.5547	**220**	485.0169	**320**	705.4791	**420**	925.9414	**520**	1,146.4036	**620**	1,366.8659	**720**	1,587.3281	**820**	1,807.7903	**920**	2,028.2526
1	46.2971	1	266.7593	1	487.2215	1	707.6838	1	928.1460	1	1,148.6082	1	1,369.0705	1	1,589.5327	1	1,809.9949	1	2,030.4572
2	48.5017	2	268.9639	2	489.4262	2	709.8884	2	930.3506	2	1,150.8129	2	1,371.2751	2	1,591.7373	2	1,812.1996	2	2,032.6618
3	50.7063	3	271.1685	3	491.6308	3	712.0930	3	932.5553	3	1,153.0175	3	1,373.4797	3	1,593.9420	3	1,814.4042	3	2,034.8664
4	52.9109	4	273.3732	4	493.8354	4	714.2976	4	934.7599	4	1,155.2221	4	1,375.6843	4	1,596.1466	4	1,816.6088	4	2,037.0710
5	55.1156	5	275.5778	5	496.0400	5	716.5023	5	936.9645	5	1,157.4267	5	1,377.8890	5	1,598.3512	5	1,818.8134	5	2,039.2757
6	57.3202	6	277.7824	6	498.2446	6	718.7069	6	939.1691	6	1,159.6314	6	1,380.0936	6	1,600.5558	6	1,821.0181	6	2,041.4803
7	59.5248	7	279.9870	7	500.4493	7	720.9115	7	941.3737	7	1,161.8360	7	1,382.2982	7	1,602.7604	7	1,823.2227	7	2,043.6849
8	61.7294	8	282.1917	8	502.6539	8	723.1161	8	943.5784	8	1,164.0406	8	1,384.5028	8	1,604.9651	8	1,825.4273	8	2,045.8895
9	63.9340	9	284.3963	9	504.8585	9	725.3208	9	945.7830	9	1,166.2452	9	1,386.7075	9	1,607.1697	9	1,827.6319	9	2,048.0942
30	66.1387	**130**	286.6009	**230**	507.0631	**330**	727.5254	**430**	947.9876	**530**	1,168.4498	**630**	1,388.9121	**730**	1,609.3743	**830**	1,829.8365	**930**	2,050.2988
1	68.3433	1	288.8055	1	509.2678	1	729.7300	1	950.1922	1	1,170.6545	1	1,391.1167	1	1,611.5789	1	1,832.0412	1	2,052.5034
2	70.5479	2	291.0101	2	511.4724	2	731.9346	2	952.3969	2	1,172.8591	2	1,393.3213	2	1,613.7836	2	1,834.2458	2	2,054.7080
3	72.7525	3	293.2148	3	513.6770	3	734.1392	3	954.6015	3	1,175.0637	3	1,395.5259	3	1,615.9882	3	1,836.4504	3	2,056.9126
4	74.9572	4	295.4194	4	515.8816	4	736.3439	4	956.8061	4	1,177.2683	4	1,397.7306	4	1,618.1928	4	1,838.6550	4	2,059.1173
5	77.1618	5	297.6240	5	518.0863	5	738.5485	5	959.0107	5	1,179.4730	5	1,399.9352	5	1,620.3974	5	1,840.8597	5	2,061.3219
6	79.3664	6	299.8286	6	520.2909	6	740.7531	6	961.2153	6	1,181.6776	6	1,402.1398	6	1,622.6020	6	1,843.0643	6	2,063.5265
7	81.5710	7	302.0333	7	522.4955	7	742.9577	7	963.4200	7	1,183.8822	7	1,404.3444	7	1,624.8067	7	1,845.2689	7	2,065.7311
8	83.7756	8	304.2379	8	524.7001	8	745.1624	8	965.6246	8	1,186.0868	8	1,406.5491	8	1,627.0113	8	1,847.4735	8	2,067.9358
9	85.9803	9	306.4425	9	526.9047	9	747.3670	9	967.8292	9	1,188.2914	9	1,408.7537	9	1,629.2159	9	1,849.6781	9	2,070.1404
40	88.1849	**140**	308.6471	**240**	529.1094	**340**	749.5716	**440**	970.0338	**540**	1,190.4961	**640**	1,410.9583	**740**	1,631.4205	**840**	1,851.8828	**940**	2,072.3450
1	90.3895	1	310.8518	1	531.3140	1	751.7762	1	972.2385	1	1,192.7007	1	1,413.1629	1	1,633.6252	1	1,854.0874	1	2,074.5496
2	92.5941	2	313.0564	2	533.5186	2	753.9808	2	974.4431	2	1,194.9053	2	1,415.3675	2	1,635.8298	2	1,856.2920	2	2,076.7542
3	94.7988	3	315.2610	3	535.7232	3	756.1855	3	976.6477	3	1,197.1099	3	1,417.5722	3	1,638.0344	3	1,858.4966	3	2,078.9589
4	97.0034	4	317.4656	4	537.9279	4	758.3901	4	978.8523	4	1,199.3146	4	1,419.7768	4	1,640.2390	4	1,860.7013	4	2,081.1635
5	99.2080	5	319.6702	5	540.1325	5	760.5947	5	981.0569	5	1,201.5192	5	1,421.9814	5	1,642.4436	5	1,862.9059	5	2,083.3681
6	101.4126	6	321.8749	6	542.3371	6	762.7993	6	983.2616	6	1,203.7238	6	1,424.1860	6	1,644.6483	6	1,865.1105	6	2,085.5727
7	103.6173	7	324.0795	7	544.5417	7	765.0040	7	985.4662	7	1,205.9284	7	1,426.3907	7	1,646.8529	7	1,867.3151	7	2,087.7774
8	105.8219	8	326.2841	8	546.7463	8	767.2086	8	987.6708	8	1,208.1330	8	1,428.5953	8	1,649.0575	8	1,869.5197	8	2,089.9820
9	108.0265	9	328.4887	9	548.9510	9	769.4132	9	989.8754	9	1,210.3377	9	1,430.7999	9	1,651.2621	9	1,871.7244	9	2,092.1866

EQUIVALENTS IN AVOIRDUPOIS POUNDS OF 1 TO 999 KILOGRAMS

(continued)

50	110.2311	150	330.6934	250	551.1556	350	771.6178	450	992.0801	550	1,212.5423	650	1,433.0045	750	1,653.4668	850	1,873.9290	950	2,094.3912
1	112.4357	1	332.8980	1	553.3602	1	773.8224	1	994.2847	1	1,214.7469	1	1,435.2091	1	1,655.6714	1	1,876.1336	1	2,096.5958
2	114.6404	2	335.1026	2	555.5648	2	776.0271	2	996.4893	2	1,216.9515	2	1,437.4138	2	1,657.8760	2	1,878.3382	2	2,098.8005
3	116.8450	3	337.3072	3	557.7695	3	778.2317	3	998.6939	3	1,219.1562	3	1,439.6184	3	1,660.0806	3	1,880.5429	3	2,101.0051
4	119.0496	4	339.5118	4	559.9741	4	780.4363	4	1,000.8985	4	1,221.3608	4	1,441.8230	4	1,662.2852	4	1,882.7475	4	2,103.2097
5	121.2542	5	341.7165	5	562.1787	5	782.6409	5	1,003.1032	5	1,223.5654	5	1,444.0276	5	1,664.4899	5	1,884.9521	5	2,105.4143
6	123.4589	6	343.9211	6	564.3833	6	784.8456	6	1,005.3078	6	1,225.7700	6	1,446.2323	6	1,666.6945	6	1,887.1567	6	2,107.6190
7	125.6635	7	346.1257	7	566.5879	7	787.0502	7	1,007.5124	7	1,227.9746	7	1,448.4369	7	1,668.8991	7	1,889.3613	7	2,109.8236
8	127.8681	8	348.3303	8	568.7926	8	789.2548	8	1,009.7170	8	1,230.1793	8	1,450.6415	8	1,671.1037	8	1,891.5660	8	2,112.0282
9	130.0727	9	350.5350	9	570.9972	9	791.4594	9	1,011.9217	9	1,232.3839	9	1,452.8461	9	1,673.3084	9	1,893.7706	9	2,114.2328
60	132.2773	160	352.7396	260	573.2018	360	793.6640	460	1,014.1263	560	1,234.5885	660	1,455.0507	760	1,675.5130	860	1,895.9752	960	2,116.4374
1	134.4820	1	354.9442	1	575.4064	1	795.8687	1	1,016.3309	1	1,236.7931	1	1,457.2554	1	1,677.7176	1	1,898.1798	1	2,118.6421
2	136.6866	2	357.1488	2	577.6111	2	798.0733	2	1,018.5355	2	1,238.9978	2	1,459.4600	2	1,679.9222	2	1,900.3845	2	2,120.8467
3	138.8912	3	359.3534	3	579.8157	3	800.2779	3	1,020.7401	3	1,241.2024	3	1,461.6646	3	1,682.1268	3	1,902.5891	3	2,123.0513
4	141.0958	4	361.5581	4	582.0203	4	802.4825	4	1,022.9448	4	1,243.4070	4	1,463.8692	4	1,684.3315	4	1,904.7937	4	2,125.2559
5	143.3005	5	363.7627	5	584.2249	5	804.6872	5	1,025.1494	5	1,245.6116	5	1,466.0739	5	1,686.5361	5	1,906.9983	5	2,127.4606
6	145.5051	6	365.9673	6	586.4295	6	806.8918	6	1,027.3540	6	1,247.8162	6	1,468.2785	6	1,688.7407	6	1,909.2029	6	2,129.6652
7	147.7097	7	368.1719	7	588.6342	7	809.0964	7	1,029.5586	7	1,250.0209	7	1,470.4831	7	1,690.9453	7	1,911.4076	7	2,131.8698
8	149.9143	8	370.3766	8	590.8388	8	811.3010	8	1,031.7633	8	1,252.2255	8	1,472.6877	8	1,693.1500	8	1,913.6122	8	2,134.0744
9	152.1189	9	372.5812	9	593.0434	9	813.5056	9	1,033.9679	9	1,254.4301	9	1,474.8923	9	1,695.3546	9	1,915.8168	9	2,136.2790
70	154.3236	170	374.7858	270	595.2480	370	815.7103	470	1,036.1725	570	1,256.6347	670	1,477.0970	770	1,697.5592	870	1,918.0214	970	2,138.4837
1	156.5282	1	376.9904	1	597.4527	1	817.9149	1	1,038.3771	1	1,258.8394	1	1,479.3016	1	1,699.7638	1	1,920.2261	1	2,140.6883
2	158.7328	2	379.1950	2	599.6573	2	820.1195	2	1,040.5817	2	1,261.0440	2	1,481.5062	2	1,701.9684	2	1,922.4307	2	2,142.8929
3	160.9374	3	381.3997	3	601.8619	3	822.3241	3	1,042.7864	3	1,263.2486	3	1,483.7108	3	1,704.1731	3	1,924.6353	3	2,145.0975
4	163.1421	4	383.6043	4	604.0665	4	824.5288	4	1,044.9910	4	1,265.4532	4	1,485.9155	4	1,706.3777	4	1,926.8399	4	2,147.3022
5	165.3467	5	385.8089	5	606.2711	5	826.7334	5	1,047.1956	5	1,267.6578	5	1,488.1201	5	1,708.5823	5	1,929.0445	5	2,149.5068
6	167.5513	6	388.0135	6	608.4758	6	828.9380	6	1,049.4002	6	1,269.8625	6	1,490.3247	6	1,710.7869	6	1,931.2492	6	2,151.7114
7	169.7559	7	390.2182	7	610.6804	7	831.1426	7	1,051.6049	7	1,272.0671	7	1,492.5293	7	1,712.9916	7	1,933.4538	7	2,153.9160
8	171.9605	8	392.4228	8	612.8850	8	833.3472	8	1,053.8095	8	1,274.2717	8	1,494.7339	8	1,715.1962	8	1,935.6584	8	2,156.1206
9	174.1652	9	394.6274	9	615.0896	9	835.5519	9	1,056.0141	9	1,276.4763	9	1,496.9386	9	1,717.4008	9	1,937.8630	9	2,158.3253
80	176.3698	180	396.8320	280	617.2943	380	837.7565	480	1,058.2187	580	1,278.6810	680	1,499.1432	780	1,719.6054	880	1,940.0677	980	2,160.5299
1	178.5744	1	399.0366	1	619.4989	1	839.9611	1	1,060.4233	1	1,280.8856	1	1,501.3478	1	1,721.8100	1	1,942.2723	1	2,162.7345
2	180.7790	2	401.2413	2	621.7035	2	842.1657	2	1,062.6280	2	1,283.0902	2	1,503.5524	2	1,724.0147	2	1,944.4769	2	2,164.9391
3	182.9837	3	403.4459	3	623.9081	3	844.3704	3	1,064.8326	3	1,285.2948	3	1,505.7571	3	1,726.2193	3	1,946.6815	3	2,167.1438
4	185.1883	4	405.6505	4	626.1127	4	846.5750	4	1,067.0372	4	1,287.4994	4	1,507.9617	4	1,728.4239	4	1,948.8861	4	2,169.3484
5	187.3929	5	407.8551	5	628.3174	5	848.7796	5	1,069.2418	5	1,289.7041	5	1,510.1663	5	1,730.6285	5	1,951.0908	5	2,171.5530
6	189.5975	6	410.0598	6	630.5220	6	850.9842	6	1,071.4465	6	1,291.9087	6	1,512.3709	6	1,732.8332	6	1,953.2954	6	2,173.7576
7	191.8021	7	412.2644	7	632.7266	7	853.1888	7	1,073.6511	7	1,294.1133	7	1,514.5755	7	1,735.0378	7	1,955.5000	7	2,175.9623
8	194.0068	8	414.4690	8	634.9312	8	855.3935	8	1,075.8557	8	1,296.3179	8	1,516.7802	8	1,737.2424	8	1,957.7046	8	2,178.1669
9	196.2114	9	416.6736	9	637.1359	9	857.5981	9	1,078.0603	9	1,298.5226	9	1,518.9848	9	1,739.4470	9	1,959.9093	9	2,180.3715
90	198.4160	190	418.8782	290	639.3405	390	859.8027	490	1,080.2649	590	1,300.7272	690	1,521.1894	790	1,741.6516	890	1,962.1139	990	2,182.5761
1	200.6206	1	421.0829	1	641.5451	1	862.0073	1	1,082.4696	1	1,302.9318	1	1,523.3940	1	1,743.8563	1	1,964.3185	1	2,184.7807
2	202.8253	2	423.2875	2	643.7497	2	864.2120	2	1,084.6742	2	1,305.1364	2	1,525.5987	2	1,746.0609	2	1,966.5231	2	2,186.9854
3	205.0299	3	425.4921	3	645.9543	3	866.4166	3	1,086.8788	3	1,307.3410	3	1,527.8033	3	1,748.2655	3	1,968.7278	3	2,189.1900
4	207.2345	4	427.6967	4	648.1590	4	868.6212	4	1,089.0834	4	1,309.5457	4	1,530.0079	4	1,750.4701	4	1,970.9324	4	2,191.3946
5	209.4391	5	429.9014	5	650.3636	5	870.8258	5	1,091.2881	5	1,311.7503	5	1,532.2125	5	1,752.6748	5	1,973.1370	5	2,193.5992
6	211.6437	6	432.1060	6	652.5682	6	873.0304	6	1,093.4927	6	1,313.9549	6	1,534.4171	6	1,754.8794	6	1,975.3416	6	2,195.8039
7	213.8484	7	434.3106	7	654.7728	7	875.2351	7	1,095.6973	7	1,316.1595	7	1,536.6218	7	1,757.0840	7	1,977.5462	7	2,198.0085
8	216.0530	8	436.5152	8	656.9775	8	877.4397	8	1,097.9019	8	1,318.3642	8	1,538.8264	8	1,759.2886	8	1,979.7509	8	2,200.2131
9	218.2576	9	438.7198	9	659.1821	9	879.6443	9	1,100.1065	9	1,320.5688	9	1,541.0310	9	1,761.4933	9	1,981.9555	9	2,202.4177

SECTION 9 PRESSURE

Table of Equivalents of Pressure 9-1
Conversion Factors – Pressure 9-2
Conversion Factors – Pressure Head 9-3
Barometric Pressure at Various Altitudes 9-4
Angle of Inclination of a Manometer Necessary to Produce Desired Magnification 9-7

TABLE OF EQUIVALENTS OF PRESSURE

NOTE.—The pressure units *one standard inch of mercury, one standard millimeter of mercury,* and *one standard atmosphere* are defined in terms of the conventional *standard* value of gravity 980.665 cm. sec.$^{-2}$, which was adopted by the International Committee on Weights and Measures. These units have been proposed for general meteorological use. The pressure units *one 45° inch of mercury, one 45° millimeter of mercury,* and *one 45° atmosphere* are defined in terms of the best value of gravity at 45° latitude and sea level, 980.616 cm. sec.$^{-2}$

- 1 dyne per square centimeter (dyne cm.$^{-2}$)
  - = 1 barye
  - = 10^{-3} mb.
  - = 10^{-6} bar.
- 1 millibar (mb.)
  - = 10^{3} dynes cm.$^{-2}$
  - = 0.00101972 kg. cm.$^{-2}$
  - = 0.750099 mm. Hg. (45°)
  - = 0.750062 mm. Hg. (standard)
  - = 0.0295315 in. Hg. (45°)
  - = 0.0295300 in. Hg. (standard)
  - = 0.0145038 lb. in.$^{-2}$
- 1 centibar (cb.)
  - = 10 mb.
- 1 bar (b.)
  - = 10^{6} dynes cm.$^{-2}$
  - = 10^{3} mb.
  - = 10^{6} barye
- 1 standard millimeter of mercury (mm. Hg. (standard))
  - = 1.000050 mm. Hg. (45°)
  - = 1.333224 mb.
  - = 0.001359504 kg. cm.$^{-2}$
  - = 0.03937205 in. Hg. (45°)
  - = 0.03937008 in. Hg. (standard)
  - = 0.0193368 lb. in.$^{-2}$
- 1 45° millimeter of mercury (mm. Hg. (45°))
  - = 0.999950 mm. Hg. (standard)
  - = 1.333157 mb.
  - = 0.00135944 kg. cm.$^{-2}$
  - = 0.03937008 in. Hg. (45°)
  - = 0.0393681 in. Hg. (standard)
  - = 0.0193358 lb. in.$^{-2}$
- 1 kilogram per square centimeter (kg. cm.$^{-2}$)
  - = 980665 dynes cm.$^{-2}$
  - = 980.665 mb.
  - = 735.596 mm. Hg. (45°)
  - = 735.559 mm. Hg. (standard)
  - = 28.9605 in. Hg. (45°)
  - = 28.9590 in. Hg. (standard)
  - = 14.2233 lb. in.$^{-2}$
- 1 standard inch of mercury (in. Hg. (standard))
  - = 0.491154 lb. in.$^{-2}$
  - = 33.8639 mb.
  - = 0.0345316 kg. cm.$^{-2}$
  - = 25.4013 mm. Hg. (45°)
  - = 25.4 mm. Hg. (standard)
- 1 45° inch of mercury (in. Hg. (45°))
  - = 0.491130 lb. in.$^{-2}$
  - = 33.8622 mb.
  - = 0.0345298 kg. cm.$^{-2}$
  - = 25.4 mm. Hg. (45°)
  - = 25.3987 mm. Hg. (standard)
- 1 pound per square inch (lb. in.$^{-2}$, psi)
  - = 2.03612 in. Hg. (45°)
  - = 2.03602 in. Hg. (standard)
  - = 68.9476 mb.
  - = 0.0703069 kg. cm.$^{-2}$
  - = 51.7175 mm. Hg. (45°)
  - = 51.7149 mm. Hg. (standard)
- 1 standard atmosphere
  - = 1013.250 mb.
  - = 1.03323 kg. cm.$^{-2}$
  - = 760 mm. Hg. (standard)
  - = 29.9213 in. Hg. (standard)
  - = 14.6960 lb. in.$^{-2}$
  - = 760.038 mm. Hg. (45°)
  - = 29.9228 in. Hg. (45°)
  - = 1.000050 45° atmosphere
- 1 45° atmosphere
  - = 1013.200 mb.
  - = 1.03318 kg. cm.$^{-2}$
  - = 760 mm. Hg. (45°)
  - = 29.9213 in. Hg. (45°)
  - = 14.695 lb. in.$^{-2}$
  - = 759.962 mm. Hg. (standard)
  - = 29.9198 in. Hg. (standard)
  - = 0.999950 standard atmosphere
- 1 inch of water, 4° C.
  - = 2.491 mb.

CONVERSION FACTORS – PRESSURE

Desired units / Given units	$\frac{\text{gm}_\text{m}}{\text{cm-sec}^2}$	$\frac{\text{dynes}}{\text{cm}^2}$	$\frac{\#_\text{m}}{\text{ft-sec}^2}$	$\frac{\text{poundals}}{\text{ft}^2}$	$\frac{\text{gm}_\text{f}}{\text{cm}^2}$	$\frac{\#_\text{f}}{\text{ft}^2}$	$\frac{\#_\text{f}}{\text{in}^2}$	"Atmospheres"
$\frac{\text{gm}_\text{m}}{\text{cm-sec}^2}$	1	1	6.7197×10^{-2}	6.7197×10^{-2}	1.0197×10^{-3}	2.0885×10^{-3}	1.4504×10^{-5}	9.8692×10^{-7}
$\frac{\text{dynes}}{\text{cm}^2}$	1	1	6.7197×10^{-2}	6.7197×10^{-2}	1.0197×10^{-3}	2.0885×10^{-3}	1.4504×10^{-5}	9.8692×10^{-7}
$\frac{\#_\text{m}}{\text{ft-sec}^2}$	14.882	14.882	1	1	1.5175×10^{-2}	3.1081×10^{-2}	2.1584×10^{-4}	1.4687×10^{-5}
$\frac{\text{poundals}}{\text{ft}^2}$	14.882	14.882	1	1	1.5175×10^{-2}	3.1081×10^{-2}	2.1584×10^{-4}	1.4687×10^{-5}
$\frac{\text{gm}_\text{f}}{\text{cm}^2}$	980.665	980.665	65.898	65.898	1	2.0482	1.4223×10^{-2}	9.6784×10^{-4}
$\frac{\#_\text{f}}{\text{ft}^2}$	478.80	478.80	32.174	32.174	4.8824×10^{-1}	1	6.9444×10^{-3}	4.7254×10^{-4}
$\frac{\#_\text{f}}{\text{in}^2}$	6.8948×10^{4}	6.8948×10^{4}	4.6331×10^{3}	4.6331×10^{3}	70.307	144.00	1	6.8046×10^{-2}
"Atmospheres"	1.0133×10^{6}	1.0133×10^{6}	6.8087×10^{4}	6.8087×10^{4}	1.0332×10^{3}	2.1162×10^{3}	14.696	1

To convert a value from a given unit to a desired unit, multiply the given value by the factor opposite the given units and beneath the desired units.

CONVERSION FACTORS – PRESSURE HEAD

Desired units / Given units	Bar	Millibar	In. Hg	Cm. Hg	Mm. Hg	In. H_2O	"Atmospheres"
Bar	1	1000	29.530	75.006	750.06	401.47	9.8692×10^{-1}
Millibar	1×10^{-3}	1	2.9530×10^{-2}	7.5006×10^{-2}	7.5006×10^{-1}	4.0147×10^{-1}	9.8692×10^{-4}
In. Hg	3.3864×10^{-2}	33.864	1	2.5400	25.400	13.546	3.3421×10^{-2}
Cm. Hg	1.3332×10^{-2}	13.332	3.9370×10^{-1}	1	10	5.3525	1.3158×10^{-2}
Mm. Hg	1.3332×10^{-3}	1.3332	3.9370×10^{-2}	1×10^{-1}	1	5.3525×10^{-1}	1.3158×10^{-3}
In. H_2O	2.4909×10^{-3}	2.4909	7.3823×10^{-2}	1.8683×10^{-1}	1.8683	1	2.4583×10^{-3}
"Atmospheres"	1.0133	1.0133×10^{3}	29.291	76	760	406.79	1

To convert a value from a given unit to a desired unit, multiply the given value by the factor opposite the given units and beneath the desired units.

BAROMETRIC PRESSURE AT VARIOUS ALTITUDES

[Abridged from the Smithsonian Tables]

Values of 60368 [1+0.0010195×36] log. $\frac{29.90}{B}$

Barometric pressure, B inches	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
17.00	15,347	15,331	15,315	15,299	15,283	15,267	15,251	15,235	15,219	15,203
.10	15,187	15,172	15,156	15,140	15,124	15,108	15,092	15,076	15,061	15,045
.20	15,029	15,013	14,997	14,982	14,966	14,950	14,934	14,919	14,903	14,887
.30	14,871	14,856	14,840	14,824	14,809	14,793	14,777	14,762	14,746	14,730
.40	14,715	14,699	14,684	14,668	14,652	14,637	14,621	14,606	14,590	14,575
17.50	14,559	14,544	14,528	14,512	14,497	14,481	14,466	14,451	14,435	14,420
.60	14,404	14,389	14,373	14,358	14,342	14,327	14,312	14,296	14,281	14,266
.70	14,250	14,235	14,219	14,204	14,189	14,173	14,158	14,143	14,128	14,112
.80	14,097	14,082	14,067	14,051	14,036	14,021	14,006	13,990	13,975	13,960
.90	13,945	13,930	13,914	13,899	13,884	13,869	13,854	13,839	13,824	13,808
18.00	13,793	13,778	13,763	13,748	13,733	13,718	13,703	13,688	13,673	13,658
.10	13,643	13,628	13,613	13,598	13,583	13,568	13,553	13,538	13,523	13,508
.20	13,493	13,478	13,463	13,448	13,433	13,418	13,404	13,389	13,374	13,359
.30	13,344	13,329	13,314	13,300	13,285	13,270	13,255	13,240	13,226	13,211
.40	13,196	13,181	13,166	13,152	13,137	13,122	13,107	13,093	13,078	13,063
18.50	13,049	13,034	13,019	13,005	12,990	12,975	12,961	12,946	12,931	12,917
.60	12,902	12,888	12,873	12,858	12,844	12,829	12,815	12,800	12,785	12,771
.70	12,756	12,742	12,727	12,713	12,698	12,684	12,669	12,655	12,640	12,626
.80	12,611	12,597	12,583	12,568	12,554	12,539	12,525	12,510	12,496	12,482
.90	12,467	12,453	12,438	12,424	12,410	12,395	12,381	12,367	12,352	12,338
19.00	12,324	12,310	12,295	12,281	12,267	12,252	12,238	12,224	12,210	12,195
.10	12,181	12,167	12,153	12,138	12,124	12,110	12,096	12,082	12,068	12,053
.20	12,039	12,025	12,011	11,997	11,983	11,969	11,954	11,940	11,926	11,912
.30	11,898	11,884	11,870	11,856	11,842	11,828	11,814	11,800	11,786	11,772
.40	11,758	11,744	11,730	11,716	11,702	11,688	11,674	11,660	11,646	11,632
19.50	11,618	11,604	11,590	11,576	11,562	11,548	11,534	11,520	11,507	11,493
.60	11,479	11,465	11,451	11,437	11,428	11,410	11,396	11,382	11,368	11,354
.70	11,340	11,327	11,313	11,299	11,285	11,272	11,258	11,244	11,230	11,217
.80	11,203	11,189	11,175	11,162	11,148	11,134	11,121	11,107	11,093	11,080
.90	11,066	11,052	11,039	11,025	11,011	10,998	10,984	10,970	10,957	10,943
20.00	10,930	10,916	10,903	10,889	10,875	10,862	10,848	10,835	10,821	10,808
.10	10,794	10,781	10,767	10,754	10,740	10,727	10,713	10,700	10,686	10,673
.20	10,659	10,646	10,632	10,619	10,605	10,592	10,579	10,565	10,552	10,538
.30	10,525	10,512	10,498	10,485	10,472	10,458	10,445	10,431	10,418	10,405
.40	10,391	10,378	10,365	10,352	10,338	10,325	10,312	10,298	10,285	10,272
20.50	10,259	10,245	10,232	10,219	10,206	10,192	10,179	10,166	10,153	10,139
.60	10,126	10,113	10,100	10,087	10,074	10,060	10,047	10,034	10,021	10,008
.70	9,995	9,982	9,968	9,955	9,942	9,929	9,916	9,903	9,890	9,877
.80	9,864	9,851	9,838	9,825	9,812	9,799	9,786	9,772	9,759	9,746
.90	9,733	9,720	9,707	9,694	9,681	9,668	9,655	9,642	9,629	9,617
21.00	9,604	9,591	9,578	9,565	9,552	9,539	9,526	9,513	9,500	9,487
.10	9,474	9,462	9,449	9,436	9,423	9,410	9,397	9,384	9,372	9,359
.20	9,346	9,333	9,320	9,307	9,295	9,282	9,269	9,256	9,244	9,231
.30	9,218	9,205	9,193	9,180	9,167	9,154	9,142	9,129	9,116	9,103
.40	9,091	9,078	9,065	9,053	9,040	9,027	9,015	9,002	8,989	8,977
21.50	8,964	8,951	8,939	8,926	8,913	8,901	8,888	8,876	8,863	8,850
.60	8,838	8,825	8,813	8,800	8,788	8,775	8,762	8,750	8,737	8,725
.70	8,712	8,700	8,687	8,675	8,662	8,650	8,637	8,625	8,612	8,600
.80	8,587	8,575	8,562	8,550	8,538	8,525	8,513	8,500	8,488	8,475
.90	8,463	8,451	8,438	8,426	8,413	8,401	8,389	8,376	8,364	8,352
22.00	8,339	8,327	8,314	8,302	8,290	8,277	8,265	8,253	8,240	8,228
.10	8,216	8,204	8,191	8,179	8,167	8,154	8,142	8,130	8,118	8,105
.20	8,093	8,081	8,069	8,056	8,044	8,032	8,020	8,008	7,995	7,983
.30	7,971	7,959	7,947	7,935	7,922	7,910	7,898	7,886	7,874	7,862
.40	7,849	7,837	7,825	7,813	7,801	7,789	7,777	7,765	7,753	7,740
22.50	7,728	7,716	7,704	7,692	7,680	7,668	7,656	7,644	7,632	7,620
.60	7,608	7,596	7,584	7,572	7,560	7,548	7,536	7,524	7,512	7,500
.70	7,488	7,476	7,464	7,452	7,440	7,428	7,416	7,404	7,392	7,380
.80	7,368	7,356	7,345	7,333	7,321	7,309	7,297	7,285	7,273	7,261
.90	7,249	7,238	7,226	7,214	7,202	7,190	7,178	7,166	7,155	7,143
23.00	7,131	7,119	7,107	7,096	7,084	7,072	7,060	7,048	7,037	7,025
.10	7,013	7,001	6,990	6,978	6,966	6,954	6,943	6,931	6,919	6,907
.20	6,896	6,884	6,872	6,861	6,849	6,837	6,825	6,814	6,802	6,790
.30	6,779	6,767	6,755	6,744	6,732	6,721	6,709	6,697	6,686	6,674
.40	6,662	6,651	6,639	6,628	6,616	6,604	6,593	6,581	6,570	6,558

See Reference No. 6

BAROMETRIC PRESSURE AT VARIOUS ALTITUDES
(continued)

Barometric pressure, B inches	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
23.50	6,546	6,535	6,523	6,512	6,500	6,489	6,477	6,466	6,454	6,443
.60	6,431	6,420	6,408	6,397	6,385	6,374	6,362	6,351	6,339	6,328
.70	6,316	6,305	6,293	6,282	6,270	6,259	6,247	6,236	6,225	6,213
.80	6,202	6,190	6,179	6,167	6,156	6,145	6,133	6,122	6,110	6,099
.90	6,088	6,076	6,065	6,054	6,042	6,031	6,020	6,008	5,997	5,986
24.00	5,974	5,963	5,952	5,940	5,929	5,918	5,906	5,895	5,884	5,872
.10	5,861	5,850	5,839	5,827	5,816	5,805	5,794	5,782	5,771	5,760
.20	5,749	5,737	5,726	5,715	5,704	5,693	5,681	5,670	5,659	5,648
.30	5,637	5,625	5,614	5,603	5,593	5,581	5,570	5,558	5,547	5,536
.40	5,525	5,514	5,503	5,492	5,480	5,469	5,458	5,447	5,436	5,425
24.50	5,414	5,403	5,392	5,381	5,369	5,358	5,347	5,336	5,325	5,314
.60	5,303	5,292	5,281	5,270	5,259	5,248	5,237	5,226	5,215	5,204
.70	5,193	5,182	5,171	5,160	5,149	5,138	5,127	5,116	5,105	5,094
.80	5,083	5,072	5,061	5,050	5,039	5,028	5,017	5,006	4,995	4,985
.90	4,974	4,963	4,952	4,941	4,930	4,919	4,908	4,897	4,886	4,876
25.00	4,865	4,854	4,843	4,832	4,821	4,810	4,800	4,789	4,778	4,767
.10	4,756	4,745	4,735	4,724	4,713	4,702	4,691	4,681	4,070	4,659
.20	4,648	4,637	4,627	4,616	4,605	4,594	4,584	4,573	4,562	4,551
.30	4,540	4,530	4,519	4,508	4,498	4,487	4,476	4,465	4,455	4,444
.40	4,433	4,423	4,412	4,401	4,391	4,380	4,369	4,358	4,348	4,337
25.50	4,326	4,316	4,305	4,295	4,284	4,273	4,263	4,252	4,241	4,231
.60	4,220	4,209	4,199	4,188	4,178	4,167	4,156	4,146	4,135	4,125
.70	4,114	4,104	4,093	4,082	4,072	4,061	4,051	4,040	4,030	4,019
.80	4,009	3,998	3,988	3,977	3,966	3,956	3,945	3,935	3,924	3,914
.90	3,903	3,893	3,882	3,872	3,861	3,851	3,841	3,830	3,820	3,809
26.00	3,799	3,788	3,778	3,767	3,757	3,746	3,736	3,726	3,715	3,705
.10	3,694	3,684	3,674	3,663	3,653	3,642	3,632	3,622	3,611	3,601
.20	3,590	3,580	3,570	3,559	3,549	3,539	3,528	3,518	3,508	3,497
.30	3,487	3,477	3,466	3,456	3,446	3,435	3,425	3,415	3,404	3,394
.40	3,384	3,373	3,363	3,353	3,343	3,332	3,322	3,312	3,301	3,291
26.50	3,281	3,270	3,260	3,250	3,240	3,230	3,219	3,209	3,199	3,189
.60	3,179	3,168	3,158	3,148	3,138	3,128	3,117	3,107	3,097	3,087
.70	3,077	3,066	3,056	3,046	3,036	3,026	3,016	3,005	2,995	2,985
.80	2,975	2,965	2,955	2,945	2,934	2,924	2,914	2,904	2,894	2,884
.90	2,874	2,864	2,854	2,843	2,833	2,823	2,813	2,803	2,793	2,783
27.00	2,773	2,763	2,753	2,743	2,733	2,723	2,713	2,703	2,692	2,682
.10	2,672	2,662	2,652	2,642	2,632	2,622	2,612	2,602	2,592	2,582
.20	2,572	2,562	2,552	2,542	2,532	2,522	2,512	2,502	2,493	2,483
.30	2,473	2,463	2,453	2,443	2,433	2,423	2,413	2,403	2,393	2,383
.40	2,373	2,363	2,353	2,343	2,334	2,324	2,314	2,304	2,294	2,284
27.50	2,274	2,264	2,254	2,245	2,235	2,225	2,215	2,205	2,195	2,185
.60	2,176	2,166	2,156	2,146	2,136	2,126	2,116	2,107	2,097	2,087
.70	2,077	2,067	2,058	2,048	2,038	2,028	2,018	2,009	1,999	1,989
.80	1,989	1,970	1,960	1,950	1,940	1,930	1,921	1,911	1,901	1,891
.90	1,872	1,872	1,862	1,852	1,843	1,833	1,823	1,814	1,804	1,794
28.00	1,784	1,775	1,765	1,755	1,746	1,736	1,726	1,717	1,707	1,697
.10	1,688	1,678	1,668	1,659	1,649	1,639	1,630	1,620	1,610	1,601
.20	1,591	1,581	1,572	1,562	1,552	1,543	1,533	1,524	1,514	1,504
.30	1,495	1,485	1,476	1,466	1,456	1,447	1,437	1,428	1,418	1,408
.40	1,399	1,389	1,380	1,370	1,361	1,351	1,342	1,332	1,322	1,313
28.50	1,303	1,294	1,284	1,275	1,265	1,256	1,246	1,237	1,227	1,218
.60	1,208	1,199	1,189	1,180	1,170	1,161	1,151	1,142	1,132	1,123
.70	1,113	1,104	1,094	1,085	1,075	1,066	1,057	1,047	1,038	1,028
.80	1,019	1,009	1,000	990	981	972	962	953	943	934
.90	925	915	906	896	887	878	868	859	849	840
29.00	831	821	812	803	794	784	775	765	756	746
.10	737	728	718	709	700	690	681	672	663	653
.20	644	635	625	616	607	597	588	579	570	560
.30	551	542	532	523	514	505	495	486	477	468
.40	458	449	440	431	421	412	403	394	384	375
29.50	366	357	348	338	329	320	311	302	292	283
.60	274	265	256	247	237	228	219	210	201	192
.70	182	173	164	155	146	137	128	118	109	100
.80	+91	+82	+73	+64	+55	+45	+36	+27	+18	+9
.90	0	−9	−18	−27	−36	−45	−55	−64	−73	−82
30.00	−91	−100	−109	−118	−127	−136	−145	−154	−163	−172
.10	−181	−190	−199	−208	−217	−226	−235	−244	−253	−262
.20	−271	−280	−289	−298	−307	−316	−325	−334	−343	−352
.30	−361	−370	−379	−388	−397	−406	−415	−424	−433	−442
.40	−451	−460	−469	−478	−486	−495	−504	−513	−522	−531
30.50	−540	−549	−558	−567	−576	−585	−593	−602	−611	−620
.60	−629	−638	−647	−656	−665	−673	−632	−691	−700	−709
.70	−718	−727	−735	−744	−753	−762	−771	−780	−788	−797
.80	−806	−815	−824	−833	−841	−850	−859	−868	−877	−885

BAROMETRIC PRESSURE AT VARIOUS ALTITUDES
(continued)

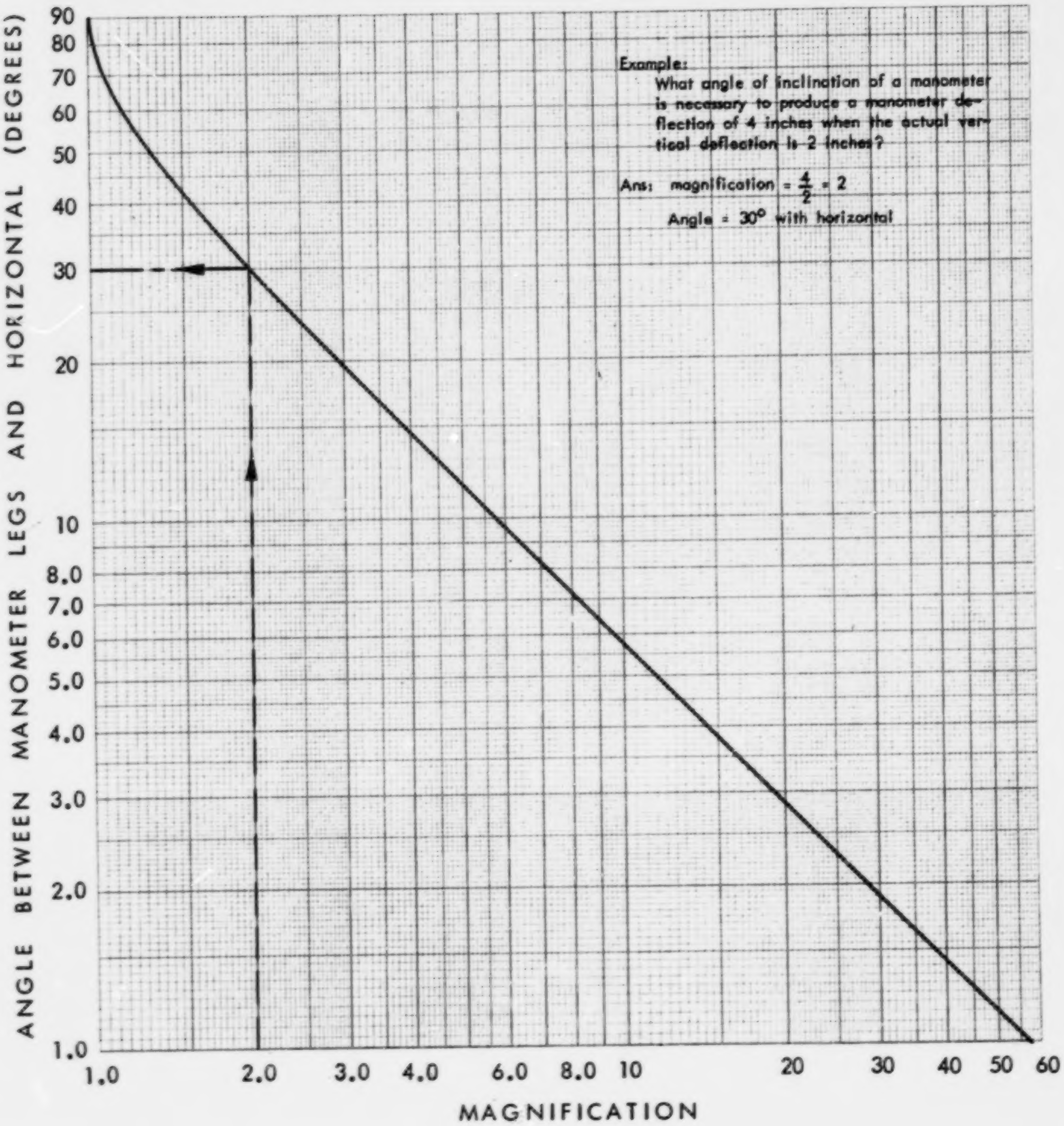
[Abridged from the Smithsonian Tables]

Term for temperature: 0.002039 (T—50°) z

For temperatures {above 50° F. / below 50° F.} the values are to be {added / subtracted}

Mean temperature T.		Approximate elevations obtained from Table VI									
		1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
°F.	*°F.*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
49	51	2	4	6	8	10	12	14	16	18	20
48	52	4	8	12	16	20	24	29	33	37	41
47	53	6	12	18	24	31	37	43	49	55	61
46	54	8	16	24	33	41	49	57	65	73	82
45	55	10	20	31	41	51	61	71	82	92	102
44	56	12	24	37	49	61	73	86	98	110	122
43	57	14	29	43	57	71	86	100	114	128	143
42	58	16	33	49	65	82	98	114	130	147	163
41	59	18	37	55	73	92	110	128	147	165	184
40	60	20	41	61	82	102	122	143	163	184	204
39	61	22	45	67	90	112	135	157	179	202	224
38	62	24	49	73	98	122	147	171	196	220	245
37	63	27	53	80	106	133	159	186	212	239	265
36	64	29	57	86	114	143	171	200	228	257	285
35	65	31	61	92	122	153	184	214	245	275	306
34	66	33	65	98	130	163	196	228	261	294	326
33	67	35	69	104	139	173	208	243	277	312	347
32	68	37	73	110	147	184	220	257	294	330	367
31	69	39	77	116	155	194	232	271	310	349	387
30	70	41	82	122	163	204	245	285	326	367	408
29	71	43	86	128	171	214	257	300	343	385	428
28	72	45	90	135	179	224	269	314	359	404	449
27	73	47	94	141	188	234	281	328	375	422	469
26	74	49	98	147	196	245	294	343	391	440	489
25	75	51	102	153	204	255	306	357	408	459	510
24	76	53	106	159	212	265	318	371	424	477	530
23	77	55	110	165	220	275	330	385	440	495	551
22	78	57	114	171	228	285	343	400	457	514	571
21	79	59	118	177	236	296	355	414	473	532	591
20	80	61	122	184	245	306	367	428	489	551	612
19	81	63	126	190	253	316	379	442	506	569	632
18	82	65	130	196	261	326	391	457	522	587	652
17	83	67	135	202	269	336	404	471	538	606	673
16	84	69	139	208	277	347	416	485	555	624	693
15	85	71	143	214	285	357	428	500	571	642	714
14	86	73	147	220	294	367	440	514	587	661	734
13	87	75	151	226	302	377	453	528	604	679	754
12	88	77	155	232	310	387	465	542	620	697	775
11	89	80	159	239	318	398	477	557	636	716	795
10	90	82	163	245	326	408	489	571	652	734	816
9	91	84	167	251	334	418	502	585	669	752	836
8	92	86	171	257	343	428	514	599	685	771	856
7	93	88	175	263	351	438	526	614	701	789	877
6	94	90	179	269	359	449	538	628	718	807	897
5	95	92	184	275	367	459	551	642	734	826	918
4	96	94	188	281	375	469	563	657	750	844	938
3	97	96	192	287	383	479	575	671	767	862	958
2	98	98	196	294	391	489	587	685	783	881	979
1	99	100	200	300	400	500	599	699	799	899	999
0	100	102	204	306	408	510	612	714	816	918	1,020

ANGLE OF INCLINATION OF A MANOMETER NECESSARY TO PRODUCE DESIRED MAGNIFICATION



Example:

What angle of inclination of a manometer is necessary to produce a manometer deflection of 4 inches when the actual vertical deflection is 2 inches?

Ans: magnification = $\frac{4}{2}$ = 2

Angle = 30° with horizontal

See Reference No. 20

SECTION 10 PROPERTIES OF PARTICULATES

Specific Gravities of Wind Erosion Products, Industrial Dusts and Combustion Products 10-1
Specific Gravities of Some Common Minerals 10-2
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Physical Properties of Flyash 10-10
Standard U.S. and Tyler Screen Scales 10-11

SPECIFIC GRAVITIES OF WIND EROSION PRODUCTS, INDUSTRIAL DUSTS AND COMBUSTION PRODUCTS

Specific gravity	Wind erosion products	Industrial dusts	Combustion products
0-1		sawdust	cenospheres incinerator ash
1-1.6	most fibers, biological materials: starches, etc.	plastics, gums, resins, most organic compounds, many hydrated salts like $Na_2SO_4 \cdot 12H_2O$, $Na_2CO_3 \cdot CaCO_3 \cdot 5H_2O$ (Carnallite)	most smoke
1.6-2.6	sand	glass wool, KCl, $NaNO_3$, sand, paint spray, borax, clays, alums, sylvite, phosphates	public utilities, paint, flyash
2.6-3.3	calcite, feldspars, micas, dolomite	talc, micas, cryolite, fluorite	
> 3.3	barite, aragonite, cinnabar, periclase, pyrolusite, realgar, rutile, siderite, sphalerite	asbestos, metal powders, corundum, lime, galena, garnets, barium, strontium, hematite, lead salts, etc., magnetite, marcasite, pyrite, willemite, zincite	

SPECIFIC GRAVITIES OF SOME COMMON MINERALS

Borax	1.7
Sylvite	1.99
Bauxite	2.0 - 2.55
Sulfur	2.05 - 2.09
Stilbite	2.1 - 2.2
Halite	2.16
Serpentine	2.2 - 2.65
Natrolite	2.25
Sodalite	2.30
Graphite	2.3
Gypsum	2.32
Apophyllite	2.3 - 2.4
Brucite	2.39
Leucite	2.45 - 2.50
Microcline	2.54 - 2.57
Orthoclase	2.57
Nepheline	2.55 - 2.65
Kaolinite	2.6 - 2.63
Albite	2.62
Oligoclase	2.65
Quartz	2.65
Andesine	2.69
Labradorite	2.71
Scapolite	2.65 - 2.74
Calcite	2.72
Plagioclase	2.62 - 2.76
Talc	2.7 - 2.8
Anorthite	2.76
Beryl	2.75 - 2.8
Wollastonite	2.8 - 2.9
Dolomite	2.85
Phlogopite	2.86
Muscovite	2.76 - 3.1
Lepidolite	2.8 - 3.0
Anhydrite	2.89 - 2.98
Aragonite	2.95
Biotite	2.8 - 3.2
Cryolite	2.95 - 3.0
Amblygonite	3.0 - 3.1
Lazulite	3.0 - 3.1
Magnesite	3.0 - 3.2
Tourinaline	3.0 - 3.25
Tremolite	3.0 - 3.3
Apatite	3.15 - 3.20
Spodumene	3.15 - 3.30
Andalusite	3.16 - 3.20
Fluorite	3.18
Hornblende	3.2
Sillimanite	3.23
Diopside	3.2 - 3.3
Augite	3.2 - 3.4
Olivine	3.27 - 4.37
Enstatite	3.2 - 3.5
Diaspore	3.35 - 3.45
Epidote	3.35 - 3.45
Hemimorphite	3.4 - 3.5
Sphene	3.4 - 3.55
Realgar	3.48
Diamond	3.5
Rhodochrosite	3.45 - 3.60
Garnet	3.5 - 4.3
Spinel	3.6 - 4.0
Kyanite	3.56 - 3.66
Rhodonite	3.58 - 3.70
Staurolite	3.65 - 3.75
Chrysoberyl	3.65 - 3.8
Azurite	3.77
Siderite	3.83 - 3.88
Malachite	3.9 - 4.03
Celestite	3.95 - 3.97
Sphalerite	3.9 - 4.1
Corundum	4.02
Willemite	3.9 - 4.2
Chalcopyrite	4.1 - 4.3
Rutile	4.18 - 4.25
Enargite	4.43 - 4.45
Barite	4.5
Stibnite	4.52 - 4.62
Ilmenite	4.7
Pyrolusite	4.75
Molybdenite	4.62 - 4.73
Zircon	4.68
Marcasite	4.89
Pyrite	5.02
Franklinite	5.15
Magnetite	5.18
Zincite	5.68
Cuprite	6.0
Arsenopyrite	6.07
Cerussite	6.55
Cassiterite	6.8 - 7.1
Galena	7.4 - 7.6
Cinnabar	8.10
Copper	8.9
Silver	10.5

SPECIFIC GRAVITIES OF COMMON METALS

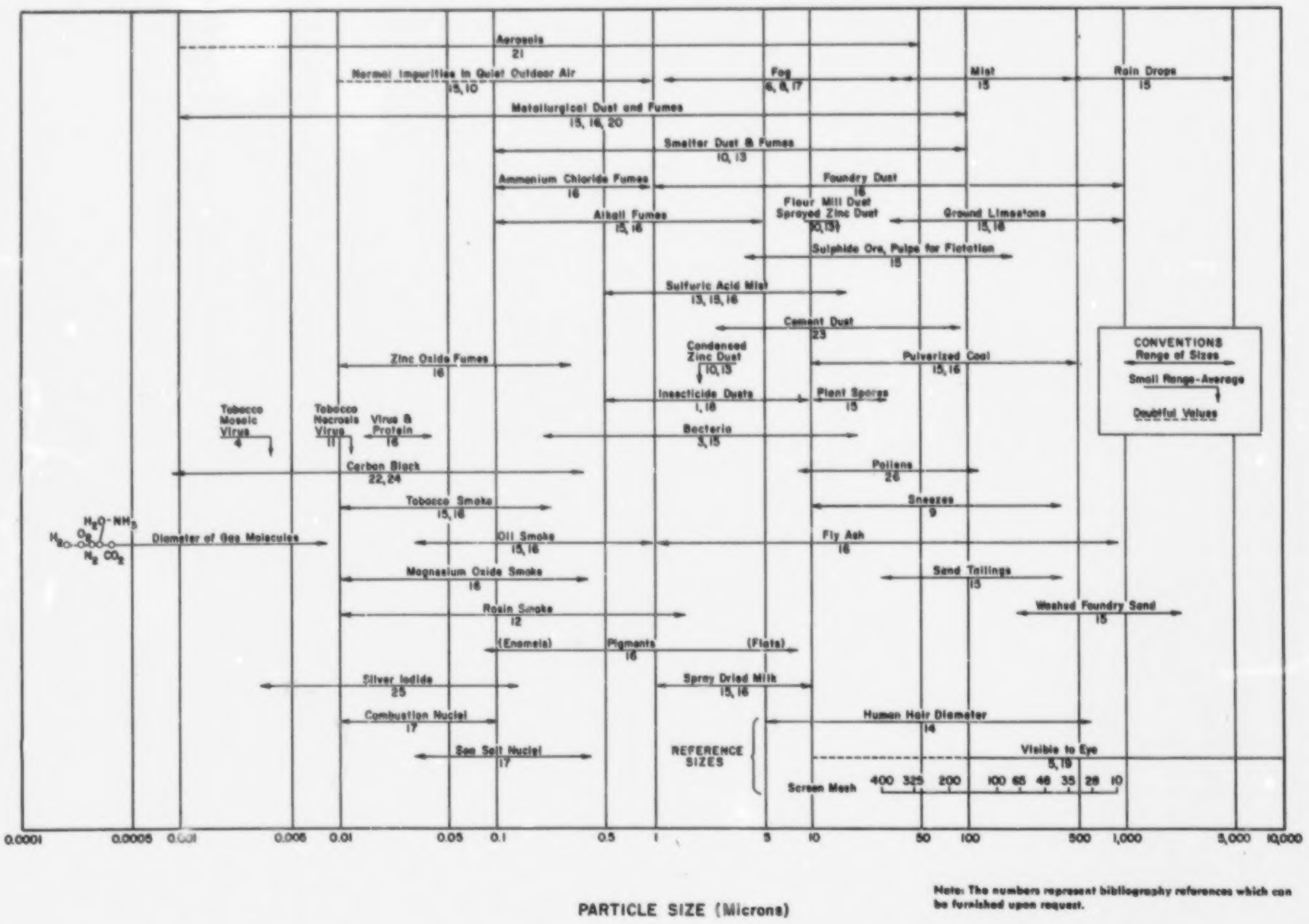
element	symbol	sp. gr.	element	symbol	sp. gr.
Aluminum	Al	2.699	Niobium	Nb	8.4
Antimony	Sb	6.618	Osmium	Os	22.5
Arsenic	As	5.13	Palladium	Pd	12.16
Barium	Ba	3.5	Platinum	Pt	21.37
Beryllium	Be	1.84	Potassium	K	0.87
Bismuth	Bi	9.781	Praseodymium	Pr	6.475
Cadmium	Cd	8.648	Rhenium	Re	20.53
Calcium	Ca	1.54	Rhodium	Rh	12.44
Cerium	Ce	6.90	Rubidium	Rb	1.532
Cesium	Cs	1.873	Ruthenium	Ru	12.06
Chromium	Cr	6.92	Selenium	Se	4.3-8
Cobalt	Co	8.71	Silver	Ag	10.492
Copper	Cu	8.92	Sodium	Na	0.9712
Gallium	Ga	5.903	Strontium	Sr	2.50-58
Germanium	Ge	5.46	Tantalum	Ta	16.6
Gold	Au	18.88	Tellurium	Te	6.25
Indium	In	7.28	Thallium	Tl	11.86
Iridium	Ir	22.42	Thorium	Th	11.3
Iron	Fe	7.85	Tin (white)	Sn	7.29
Lanthanum	La	6.15	Tin (grey)	Sn	5.8
Lead	Pb	11.342	Titanium	Ti	4.5
Lithium	Li	0.534	Tungsten	W	18.6-19.1
Magnesium	Mg	1.741	Uranium	U	18.7
Manganese	Mn	7.42	Vanadium	V	5.96
Mercury	Hg	13.546	Yttrium	Y	5.51
Molybdenum	Mo	10.2	Zinc	Zn	6.92
Neodymium	Nd	6.96	Zirconium	Zr	6.44
Nickel	Ni	8.60-90			

DIAMETERS AND SPECIFIC GRAVITIES OF SELECTED POLLEN GRAINS

Common Name	Botanical Name	Diameter in Microns	Specific Gravity
Giant ragweed	Ambrosia trifida	19.25	0.52
Burweed marsh elder	Iva xanthifolia	19.3	0.79
Short ragweed	Ambrosia elatior	20.0	0.55 *
False ragweed	Franseria acanthicarpa	22.0	0.75
Marsh elder	Iva ciliata	23.0	0.58
Southern ragweed	Ambrosia bidentata	23.0	0.50
Western ragweed	Ambrosia psilostachya	26.4	0.57
Cocklebur	Xanthium commune	27.0	0.45
Russian thistle	Salsola pestifer	23.6	0.90
Palmer's amaranth	Amaranthus palmeri	25.8	1.02
Western water hemp	Acnida tamariscina	27.5	1.01
Mexican fireweed	Kochia scoparia	32.7	0.97
Annual sage	Artemisia annua	20.4	1.02
Tall wormwood	Artemisia caudata	21.0	1.04
Sagebrush	Artemisia tridentata	25.85	1.03
Nettle	Urtica gracilis	14.0	0.77
Red sorrel	Rumex acetosella	21.45	0.78
Hemp	Cannabis sativa	25.0	0.82
English plantain	Plantago lanceolata	27.5	0.97
Bluegrass	Poa pratensis	28.0	0.90
Bluegrass	Poa pratensis	30.0	0.90
Bermuda grass	Capriola dactylon	28.5	1.01
Orchard grass	Dactylis glomerata	34.0	0.91
Timothy	Phleum pratense	34.0	0.90
Rye	Secale cereale	49.5	0.98
Corn	Zea mays	90.0	1.00
Sycamore	Platanus occidentalis	22.22	0.92
Mountain cedar	Juniperus sabinoides	22.8	1.08
Hazelnut	Corylus americana	23.6	1.09
Birch	Betula nigra	24.6	0.94
Alder	Alnus glutinosa	26.0	0.97
Ash	Fraxinus americana	27.1	0.90
Cottonwood	Populus virginiana	30.0	0.79
Elm	Ulmus americana	31.2	1.00
Bur oak	Quercus macrocarpa	32.3	1.04
Shingle oak	Quercus imbricaria	33.1	1.04
Walnut	Juglans nigra	35.75	0.93
Beech	Fagus grandifolia	44.0	0.94
Hickory	Carya ovata	45.0	0.79
Scotch pine	Pinus sylvestris	52.0	0.45
Bull pine	Pinus ponderosa	60.0	0.45

* Crawford, J. H., Pub. Health Rep. 64:1195, 1949, reports a value of 1.3.

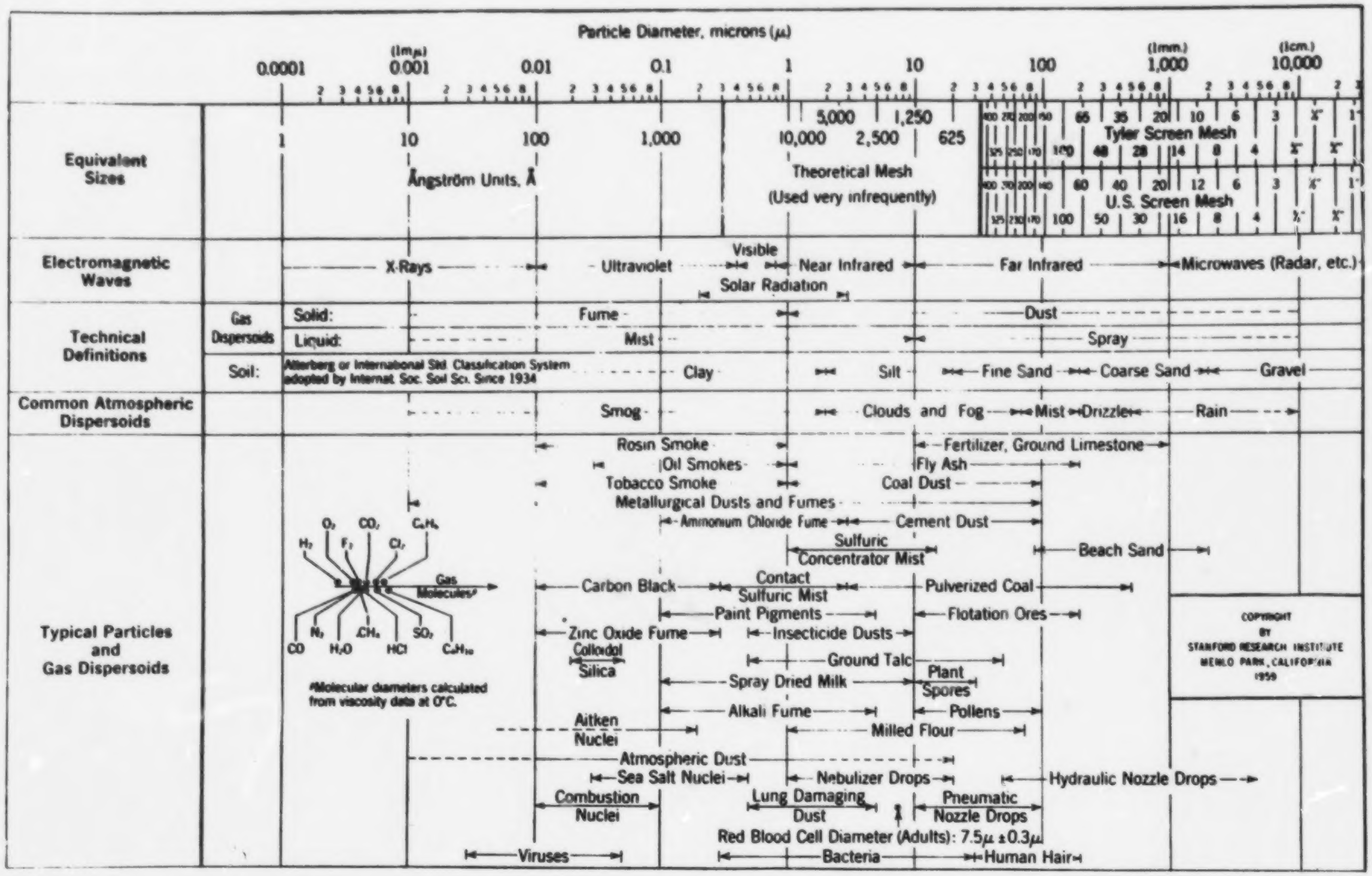
SIZES OF AIR-BORNE PARTICULATES (M.S.A.)



Note: The numbers represent bibliography references which can be furnished upon request.

See Reference No. 7

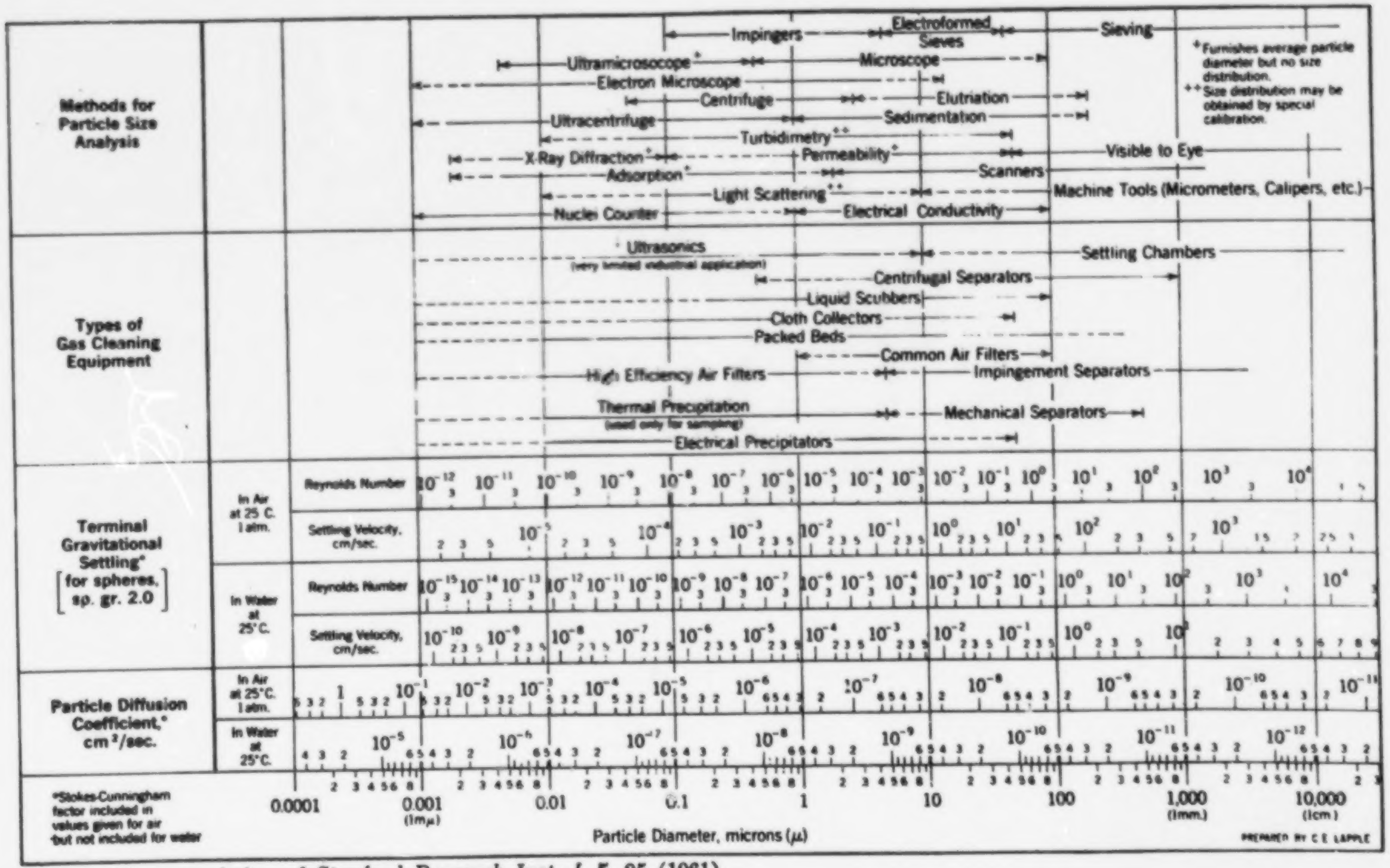
CHARACTERISTICS OF PARTICLES AND PARTICLE DISPERSOIDS (S.R.I.)



See Reference No. 9

CHARACTERISTICS OF PARTICLES AND PARTICLE DISPERSOIDS (S.R.I.)

(continued)



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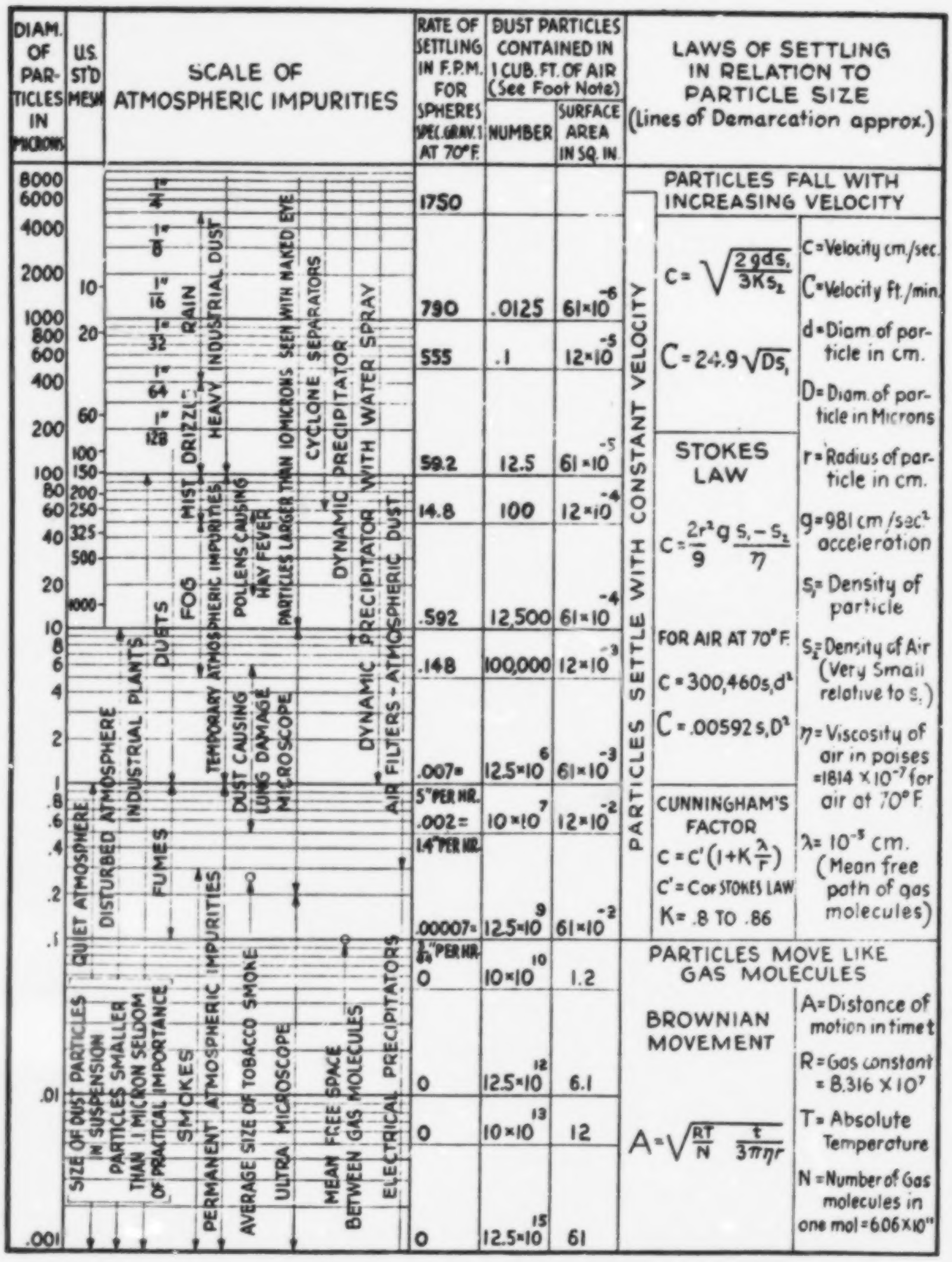
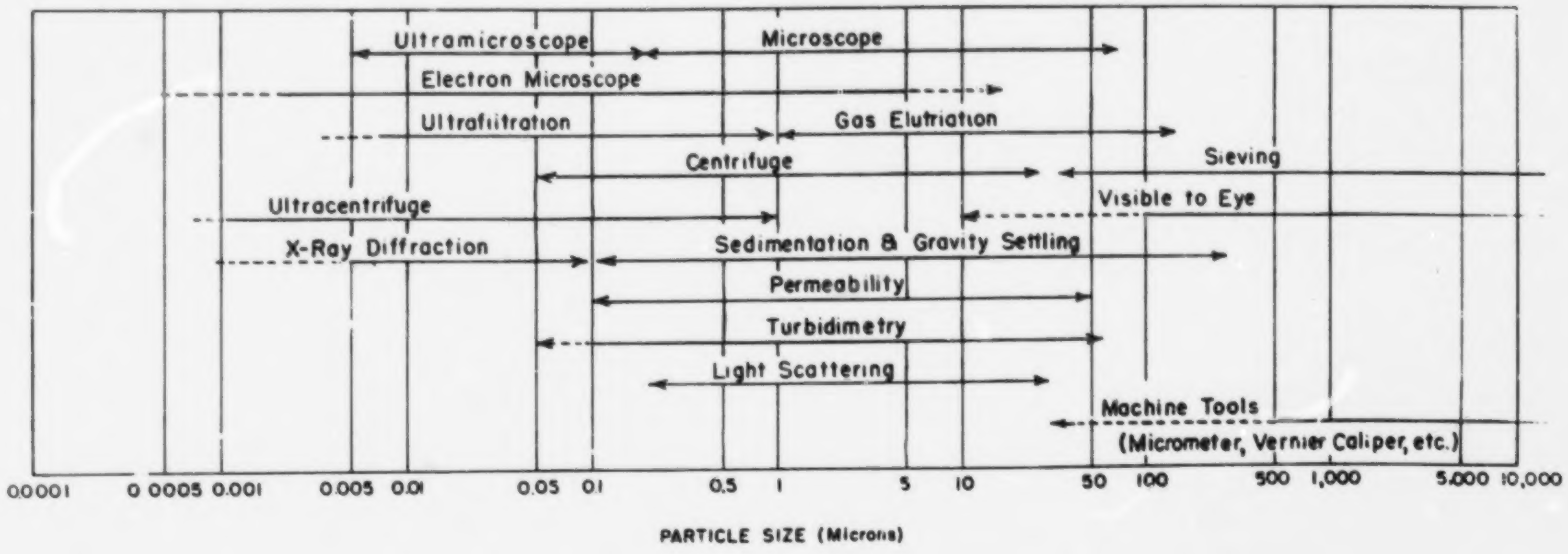
SIZE AND CHARACTERISTICS OF AIR-BORNE SOLIDS (FRANK CHART)



IT IS ASSUMED THAT THE PARTICLES ARE OF UNIFORM SPHERICAL SHAPE HAVING SPECIFIC GRAVITY ONE AND THAT THE DUST CONCENTRATION IS 0.1 GRAINS PER 1000 CU. FT. OF AIR, THE AVERAGE OF METROPOLITAN DISTRICTS.

See Reference No. 8

LIMITS OF PARTICLE SIZE MEASURING EQUIPMENT



←——→ Particle size limits under average conditions.

←- - - -→ Stated method is of doubtful utility in these size ranges.

See Reference No. 7

PHYSICAL PROPERTIES OF FLYASH

ANALYSIS AND PHYSICAL PROPERTIES OF FLY ASH, PER CENT BY WEIGHT AS COLLECTED DRIED

Constituent	Utilities			Industrials		
Carbon as C	0.37	to	36.2	2.4	to	64
Iron, Fe_2O_3 or Fe_3O_4	2.0		26.8	10.6		43.6
Magnesium as MgO	0.06		4.77	0.10		1.49
Calcium as CaO	0.12		14.73	1.92		11.8
Aluminum as Al_2O_3	9.81		58.4	10.0		21.0
Sulfur as SO_3	0.12		24.33	0.66		28.0
Titanium as TiO_2	0.50		2.8	0.22		3.81
Carbonate as CO_3	0.05		2.6	0.05		-
Silica as SiO_2	17.3		63.6	25.0		46.0
Phosphorus as P_2O_5	0.07		47.2	0.05		1.93
Undetermined	0.08		18.9	-		-

Other Tests

Hydrogen ion concentration, pH	4.7	to	11.7	6.3	to	12
Apparent Sp. Gr.	0.8		3.0	0.77		1.45
Retained on 325-mesh screen (44 μ), %	8		95	29		84
Through 325-mesh screen (44 μ), %	5		92	16		71
F.T.A., °F.	1,910		3,000	1,980		2,900

See Reference No. 5

STANDARD U.S. AND TYLER SCREEN SCALES

Nominal Aperture width		U.S. Standard	Tyler	Nominal Aperture width		U.S. Standard	Tyler
microns	inches*			microns	inches*		
1	.00004	12500	-	420	.0165	40	-
2.5	.0001	5000	-	495	.0195	-	32
5	.0002	2500	-	500	.0197	35	-
10	.0004	1250	-	589	.0232	-	28
20	.0008	625	-	590	.0232	30	-
37	.0014	400	-	701	.0276	-	24
43	.0017	-	325	710	.0280	25	-
44	.0017	325	-	833	.0328 (1/32)	-	20
53	.0021	270	270	840	.0331	20	-
61	.0024	-	250	991	.0390	-	16
62	.0024	230	-	1000	.0394	18	-
74	.0029	200	200	1168	.0460 (3/64)	-	14
88	.0035	170	-	1190	.0469	16	-
89	.0035	-	170	1397	.0550	-	12
104	.0041	-	150	1410	.0555	14	-
105	.0041	140	-	1651	.0650 (1/16)	-	10
124	.0049	-	115	1680	.0661	12	-
125	.0049	120	-	1981	.0780 (5/64)	-	9
147	.0058	-	100	2000	.0787	10	-
149	.0059	100	-	2362	.093 (3/32)	-	8
175	.0069	-	80	2380	.0937	8	-
177	.0070	80	-	2794	.110 (7/64)	-	7
208	.0082	-	65	2830	.111	7	-
210	.0083	70	-	3327	.131 (1/8)	-	6
246	.0097	-	60	3360	.132	6	-
250	.0098	60	-	3962	.156 (5/32)	-	5
295	.0116	-	48	4000	.157	5	-
297	.0117	50	-	4699	.185 (3/16)	-	4
350	.0138	45	-	4760	.187	4	-
351	.0138	-	42	6680	.263 (1/4)	-	3
417	.0164 (1/64)	-	35				

*Numbers in parentheses indicate approximate fractions of an inch.

SECTION 11 WATER VAPOR

Saturation Vapor Pressure Over Water (°F, in Hg) – Table 11-1

Saturation Vapor Pressure Over Water (°C, Millibars) – Table 11-6

Saturation Vapor Pressure Over Water (°C, mm Hg) – Table 11-8

Low Temperature Psychrometric Chart (Metric Units) 11-9

Normal Temperature Psychrometric Chart (Metric Units) 11-10

High Temperature Psychrometric Chart (Metric Units) 11-11

Low Temperature Psychrometric Chart (English Units) 11-12

Normal Temperature Psychrometric Chart (English Units) 11-13

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Saturation Vapor Pressure Over Water (°F, in Hg) – Graph 11-15

Saturation Vapor Pressure Over Water (°C, mm Hg) – Graph 11-16

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Saturated Water Vapor as Fraction of Metered Volume as a Function of Absolute Pressure (in. Hg) and Temperature (°F) 11-21

Saturated Water Vapor as Fraction of Metered Volume as a Function of Absolute Pressure (mm. Hg) and Temperature (°C) 11-22

Psychrometric Nomographs for High and Low Pressures 11-23

Fraction of Total Volume Occupied by Water Vapor vs. Gms. of Water per Gram of Dry Air 11-29

Graphical Method for Converting Volume of Condensed Water to Volume of Water Vapor at Conditions of Temperature in °K and Pressure in mm.Hg. 11-30

Relative Humidity Tables 11-31

SATURATION VAPOR PRESSURE OVER WATER
(°F, in Hg) – TABLE

English units

Temperature	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
°F.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.
0	0.04477	0.04498	0.04519	0.04540	0.04562	0.04583	0.04604	0.04626	0.04647	0.04669
1	0.04691	0.04713	0.04735	0.04757	0.04780	0.04802	0.04824	0.04847	0.04869	0.04892
2	0.04915	0.04938	0.04961	0.04984	0.05008	0.05031	0.05054	0.05078	0.05102	0.05125
3	0.05149	0.05173	0.05197	0.05221	0.05245	0.05269	0.05293	0.05318	0.05343	0.05367
4	0.05392	0.05417	0.05442	0.05467	0.05492	0.05517	0.05543	0.05568	0.05594	0.05620
5	0.05646	0.05672	0.05698	0.05724	0.05750	0.05776	0.05803	0.05829	0.05856	0.05883
6	0.05910	0.05937	0.05964	0.05991	0.06019	0.06046	0.06074	0.06101	0.06129	0.06157
7	0.06185	0.06213	0.06242	0.06270	0.06298	0.06327	0.06355	0.06384	0.06413	0.06442
8	0.06471	0.06500	0.06530	0.06560	0.06589	0.06619	0.06649	0.06679	0.06709	0.06739
9	0.06769	0.06800	0.06830	0.06861	0.06892	0.06923	0.06954	0.06985	0.07017	0.07048
10	0.07080	0.07112	0.07144	0.07176	0.07208	0.07240	0.07272	0.07305	0.07337	0.07370
11	0.07403	0.07436	0.07469	0.07503	0.07536	0.07570	0.07604	0.07638	0.07672	0.07706
12	0.07740	0.07774	0.07809	0.07843	0.07878	0.07913	0.07948	0.07983	0.08018	0.08053
13	0.08089	0.08125	0.08161	0.08197	0.08234	0.08270	0.08307	0.08343	0.08380	0.08417
14	0.08454	0.08491	0.08528	0.08566	0.08603	0.08641	0.08679	0.08717	0.08755	0.08793
15	0.08832	0.08871	0.08910	0.08949	0.08988	0.09027	0.09067	0.09106	0.09146	0.09186
16	0.09226	0.09266	0.09306	0.09347	0.09387	0.09428	0.09469	0.09510	0.09551	0.09592
17	0.09634	0.09676	0.09718	0.09760	0.09802	0.09845	0.09888	0.09931	0.09974	0.10017
18	0.10060	0.10104	0.10147	0.10191	0.10235	0.10279	0.10323	0.10367	0.10411	0.10456
19	0.10501	0.10546	0.10592	0.10637	0.10683	0.10729	0.10775	0.10821	0.10867	0.10913
20	0.10960	0.11007	0.11054	0.11102	0.11149	0.11197	0.11245	0.11292	0.11340	0.11389
21	0.11437	0.11486	0.11535	0.11584	0.11633	0.11683	0.11733	0.11783	0.11833	0.11883
22	0.11933	0.11983	0.12034	0.12085	0.12136	0.12187	0.12238	0.12290	0.12342	0.12394
23	0.12446	0.12499	0.12552	0.12605	0.12658	0.12711	0.12764	0.12818	0.12872	0.12926
24	0.12980	0.13035	0.13090	0.13145	0.13200	0.13255	0.13310	0.13366	0.13422	0.13478
25	0.13534	0.13591	0.13647	0.13704	0.13762	0.13819	0.13877	0.13934	0.13992	0.14051
26	0.14109	0.14168	0.14226	0.14285	0.14345	0.14404	0.14464	0.14524	0.14584	0.14644
27	0.14705	0.14766	0.14827	0.14889	0.14950	0.15012	0.15074	0.15136	0.15198	0.15261
28	0.15324	0.15387	0.15450	0.15514	0.15578	0.15642	0.15706	0.15771	0.15836	0.15901
29	0.15966	0.16032	0.16097	0.16163	0.16230	0.16296	0.16362	0.16429	0.16496	0.16563
30	0.16631	0.16699	0.16767	0.16835	0.16904	0.16973	0.17042	0.17111	0.17181	0.17251
31	0.17321	0.17392	0.17462	0.17533	0.17605	0.17676	0.17747	0.17819	0.17891	0.17963
32	0.18036	0.18109	0.18182	0.18256	0.18330	0.18404	0.18478	0.18553	0.18628	0.18703
33	0.18778	0.18854	0.18929	0.19005	0.19082	0.19158	0.19235	0.19313	0.19390	0.19468
34	0.19546	0.19624	0.19703	0.19782	0.19861	0.19940	0.20020	0.20100	0.20181	0.20261
35	0.20342	0.20423	0.20504	0.20586	0.20668	0.20750	0.20833	0.20916	0.20999	0.21082
36	0.21166	0.21250	0.21334	0.21419	0.21504	0.21589	0.21675	0.21761	0.21847	0.21933
37	0.22020	0.22107	0.22194	0.22282	0.22370	0.22458	0.22547	0.22636	0.22725	0.22814
38	0.22904	0.22994	0.23084	0.23175	0.23266	0.23357	0.23449	0.23541	0.23633	0.23726
39	0.23819	0.23912	0.24006	0.24100	0.24194	0.24289	0.24384	0.24479	0.24575	0.24671
40	0.24767	0.24864	0.24960	0.25058	0.25155	0.25253	0.25352	0.25450	0.25549	0.25648
41	0.25748	0.25848	0.25948	0.26049	0.26150	0.26251	0.26353	0.26455	0.26557	0.26660
42	0.26763	0.26866	0.26970	0.27074	0.27179	0.27284	0.27389	0.27494	0.27600	0.27706
43	0.27813	0.27920	0.28027	0.28135	0.28243	0.28351	0.28460	0.28569	0.28679	0.28789
44	0.28899	0.29010	0.29121	0.29232	0.29344	0.29456	0.29569	0.29682	0.29795	0.29909
45	0.30023	0.30137	0.30252	0.30367	0.30483	0.30599	0.30715	0.30832	0.30949	0.31067
46	0.31185	0.31303	0.31422	0.31541	0.31661	0.31781	0.31901	0.32022	0.32143	0.32265
47	0.32387	0.32509	0.32632	0.32755	0.32879	0.33003	0.33127	0.33252	0.33377	0.33503
48	0.33629	0.33755	0.33882	0.34010	0.34137	0.34266	0.34394	0.34523	0.34653	0.34783
49	0.34913	0.35044	0.35175	0.35306	0.35439	0.35571	0.35704	0.35837	0.35971	0.36105
50 –	0.36240	0.36375	0.36511	0.36646	0.36783	0.36920	0.37057	0.37195	0.37333	0.37472

See Reference No. 1

SATURATION VAPOR PRESSURE OVER WATER
(°F, in Hg) – TABLE
(continued)

Temperature	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
	English units									
°F.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.
50	0.36240	0.36375	0.36511	0.36646	0.36783	0.36920	0.37057	0.37195	0.37333	0.37472
51	.37611	.37751	.37891	.38031	.38172	.38314	.38456	.38598	.38741	.38884
52	.39028	.39172	.39317	.39462	.39608	.39754	.39901	.40048	.40195	.40343
53	.40492	.40641	.40709	.40940	.41090	.41241	.41393	.41544	.41697	.41850
54	.42003	.42157	.42311	.42466	.42621	.42777	.42933	.43090	.43248	.43406
55	0.43564	0.43723	0.43882	0.44042	0.44203	0.44364	0.44525	0.44687	0.44849	0.45012
56	.45176	.45340	.45504	.45670	.45835	.46001	.46168	.46335	.46503	.46671
57	.46840	.47009	.47179	.47350	.47521	.47692	.47864	.48037	.48210	.48384
58	.48558	.48733	.48908	.49084	.49260	.49437	.49614	.49792	.49971	.50150
59	.50330	.50510	.50691	.50873	.51055	.51238	.51421	.51605	.51789	.51974
60	0.52160	0.52346	0.52533	0.52720	0.52908	0.53096	0.53285	0.53475	0.53665	0.53856
61	.54047	.54239	.54432	.54625	.54818	.55013	.55208	.55403	.55600	.55797
62	.55994	.56192	.56391	.56590	.56790	.56990	.57191	.57393	.57595	.57798
63	.58002	.58206	.58411	.58616	.58823	.59029	.59237	.59445	.59654	.59863
64	.60073	.60284	.60495	.60707	.60919	.61133	.61347	.61561	.61777	.61992
65	0.62209	0.62426	0.62644	0.62862	0.63082	0.63302	0.63522	0.63743	0.63965	0.64188
66	.64411	.64635	.64859	.65085	.65311	.65537	.65765	.65993	.66221	.66451
67	.66681	.66912	.67143	.67376	.67608	.67842	.68076	.68312	.68547	.68784
68	.69021	.69259	.69497	.69737	.69977	.70217	.70459	.70701	.70944	.71188
69	.71432	.71677	.71923	.72169	.72416	.72664	.72913	.73163	.73413	.73664
70	0.73916	0.74169	0.74422	0.74676	0.74931	0.75186	0.75443	0.75700	0.75958	0.76217
71	.76476	.76736	.76997	.77259	.77521	.77785	.78049	.78314	.78579	.78846
72	.79113	.79381	.79650	.79919	.80190	.80461	.80733	.81006	.81279	.81554
73	.81829	.82105	.82382	.82659	.82938	.83217	.83497	.83778	.84060	.84343
74	.84626	.84910	.85195	.85481	.85768	.86055	.86344	.86633	.86923	.87214
75	0.87506	0.87799	0.88092	0.88387	0.88682	0.88978	0.89275	0.89573	0.89872	0.90172
76	.90472	.90773	.91075	.91378	.91682	.91987	.92292	.92599	.92906	.93215
77	.93524	.93834	.94145	.94457	.94770	.95084	.95398	.95714	.96030	.96348
78	.96666	.96985	.97305	.97626	.97948	.98271	.98595	.98920	.99246	.99572
79	.99900	1.00228	1.00558	1.00888	1.01220	1.01552	1.01885	1.02220	1.02555	1.02891
80	1.0323	1.0357	1.0391	1.0425	1.0459	1.0493	1.0527	1.0561	1.0596	1.0630
81	1.0665	1.0700	1.0735	1.0769	1.0804	1.0840	1.0875	1.0910	1.0946	1.0981
82	1.1017	1.1053	1.1089	1.1125	1.1161	1.1197	1.1234	1.1270	1.1307	1.1343
83	1.1380	1.1417	1.1453	1.1490	1.1527	1.1564	1.1602	1.1639	1.1677	1.1714
84	1.1752	1.1790	1.1828	1.1866	1.1904	1.1943	1.1981	1.2020	1.2058	1.2097
85	1.2136	1.2175	1.2214	1.2253	1.2292	1.2332	1.2371	1.2411	1.2450	1.2490
86	1.2530	1.2570	1.2610	1.2650	1.2691	1.2731	1.2772	1.2812	1.2853	1.2894
87	1.2935	1.2976	1.3017	1.3059	1.3100	1.3142	1.3183	1.3225	1.3267	1.3309
88	1.3351	1.3393	1.3436	1.3478	1.3521	1.3564	1.3606	1.3649	1.3692	1.3736
89	1.3779	1.3822	1.3866	1.3910	1.3954	1.3998	1.4042	1.4086	1.4130	1.4174
90	1.4219	1.4264	1.4308	1.4353	1.4398	1.4443	1.4489	1.4534	1.4580	1.4625
91	1.4671	1.4717	1.4763	1.4809	1.4856	1.4902	1.4949	1.4995	1.5042	1.5089
92	1.5136	1.5183	1.5230	1.5278	1.5325	1.5373	1.5421	1.5469	1.5517	1.5565
93	1.1613	1.5661	1.5710	1.5759	1.5807	1.5856	1.5905	1.5955	1.6004	1.6053
94	1.6103	1.6153	1.6203	1.6253	1.6303	1.6353	1.6404	1.6454	1.6505	1.6556
95	1.6607	1.6658	1.6709	1.6761	1.6812	1.6864	1.6916	1.6967	1.7019	1.7072
96	1.7124	1.7176	1.7229	1.7282	1.7335	1.7388	1.7441	1.7494	1.7548	1.7601
97	1.7655	1.7709	1.7763	1.7817	1.7871	1.7926	1.7980	1.8035	1.8090	1.8145
98	1.8200	1.8255	1.8311	1.8366	1.8422	1.8478	1.8533	1.8590	1.8646	1.8702
99	1.8759	1.8816	1.8873	1.8930	1.8987	1.9045	1.9102	1.9160	1.9218	1.9276
100	1.9334	1.9392	1.9450	1.9509	1.9568	1.9626	1.9685	1.9745	1.9804	1.9863

SATURATION VAPOR PRESSURE OVER WATER
(°F, in Hg) – TABLE

(continued)

Temperature	English units									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
°F.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.
100	1.9334	1.9392	1.9450	1.9509	1.9568	1.9626	1.9685	1.9745	1.9804	1.9863
101	1.9923	1.9983	2.0043	2.0103	2.0164	2.0224	2.0285	2.0346	2.0407	2.0486
102	2.0529	2.0590	2.0652	2.0713	2.0775	2.0837	2.0899	2.0961	2.1024	2.1086
103	2.1149	2.1212	2.1275	2.1338	2,1402	2.1465	2.1529	2.1593	2.1657	2.1722
104	2,1786	2.1851	2.1916	2.1981	2.2046	2.2111	2.2176	2.2242	2.2308	2.2374
105	2.2440	2.2506	2.2573	2.2639	2.2706	2.2773	2.2840	2.2907	2.2975	2.3042
106	2.3110	2.3178	2.3246	2.3315	2.3383	2.3452	2.3521	2.3590	2.3659	2.3728
107	2.3798	2.3868	2.3938	2.4008	2.4078	2.4148	2.4219	2.4290	2.4361	2.4432
108	2.4503	2.4574	2.4646	2.4718	2.4790	2.4862	2.4935	2.5007	2.5080	2.5153
109	2.5226	2.5299	2.5373	2.5447	2.5521	2.5595	2.5669	2.5744	2.5818	2.5893
110	2.5968	2.6043	2.6118	2.6194	2.6270	2.6346	2.6422	2.6498	2.6574	2.6651
111	2.6728	2.6805	2.6882	2.6960	2.7037	2.7115	2.7193	2.7271	2.7350	2.7428
112	2.7507	2.7586	2,7665	2.7745	2.7824	2.7904	2.7984	2.8064	2.8145	2.8225
113	2.8306	2.8387	2.8468	2.8550	2.8631	2.8713	2.8795	2.8877	2.8960	2.9042
114	2.9125	2.9208	2.9291	2.9374	2.9458	2.9541	2.9625	2.9709	2.9794	2.9873
115	2.9963	3.0048	3.0133	2.0219	3.0305	3.0390	3.0477	3.0563	3.0649	3.0736
116	3.0823	3.0910	3.0997	3.1085	3.1172	3.1260	3.1348	3.1437	3.1525	3.1614
117	3.1703	3.1792	3.1882	3.1972	3.2062	3.2152	3.2242	3.2333	3.2424	3.2515
118	3.2606	3.2697	3.2789	3.2881	3.2973	3.3065	3.3158	3.3250	3.3343	3.3437
119	3.3530	3.3624	3.3718	3.3812	3.3906	3.4001	3.4096	3.4191	3.4286	3.4381
120	3.4477	3.4573	3.4669	3.4765	3.4862	3.4958	3.5056	3.5153	3.5250	3.5348
121	3.5446	3.5544	3.5643	3.5741	3.5840	3.5940	3.6039	3.6139	3.6239	3.6339
122	3.6439	3.6539	3.6640	3.6741	3.6842	3.6944	3.7046	3.7148	3.7250	3.7352
123	3.7455	3.7558	3.7661	3.7765	3.7869	3.7972	3.8077	3.8181	3.8286	3.8391
124	3.8496	3.8601	3.8707	3.8813	3.8919	3.9025	3.9132	3.9239	3.9346	3.9453
125	3.9561	3.9669	3.9777	3.9885	3.9994	4.0103	4.0212	4.0321	4.0431	4.0541
126	4.0651	4.0762	4.0872	4.0983	4.1095	4.1206	4.1318	4.1430	4.1543	4.1655
127	4.1768	4.1881	4.1994	4.2108	4.2222	4.2336	4.2450	4.2565	4.2680	4.2795
128	4.2910	4.3026	4.3141	4.3257	4.3374	4.3490	4.3507	4.3725	4.3842	4.3960
129	4.4078	4.4196	4.4315	4.4434	4.4553	4.4672	4.4792	4.4912	4.5033	4.5153
130	4.5274	4.5395	4.5517	4.5638	4.5760	4.5882	4.6005	4.6128	4.6251	4.6374
131	4.6498	4.6622	4.6746	4.6871	4.6995	4.7120	4.7246	4.7371	4.7497	4.7624
132	4.7750	4.7877	4.8004	4.8131	4.8258	4.8386	4.8514	4.8643	4.8772	4.8901
133	4.9030	4.9160	4.9290	4.9420	4.9551	4.9681	4.9813	4.9944	5.0076	5.0208
134	5.0340	5.0473	5.0605	5.0738	5.0872	5.1006	5.1140	5.1274	5.1409	5.1544
135	5.1679	5.1815	5.1951	5.2087	5.2223	5.2360	5.2497	5.2635	5.2773	5.2911
136	5.3049	5.3188	5.3327	5.3466	5.3606	5.3746	5.3886	5.4027	5.4167	5.4309
137	5.4450	5.4592	5.4734	5.4876	5.5018	5.5161	5.5305	5.5448	5.5592	5.5736
138	5.5881	5.6026	5.6171	5.6317	5.6463	5.6609	5.6755	5.6902	5.7050	5.7197
139	5.7345	5.7493	5.7642	5.7791	5.7940	5.8090	5.8239	5.8390	5.8540	5.8691
140	5.8842	5.8993	5.9145	5.9297	5.9450	5.9602	5.9755	5.9909	6.0062	6.0217
141	6.0371	6.0526	6.0681	6.0836	6.0992	6.1148	6.1305	6.1461	6.1619	6.1776
142	6.1934	6.2092	6.2251	6.2410	6.2569	6.2729	6.2889	6.3049	6.3210	6.3371
143	6.3532	6.3694	6.3856	6.4018	6.4180	6.4344	6.4507	6.4671	6.4835	6.4999
144	6.5164	6.5329	6.5495	6.5661	6.5827	6.5994	6.6160	6.6328	6.6496	6.6664
145	6.6832	6.7001	6.7170	6.7339	6.7509	6.7679	6.7850	6.8021	6.8192	6.8364
146	6.8536	6.8708	6.8881	6.9054	6.9228	6.9402	6.9576	6.9751	6.9926	7.0101
147	7.0277	7.0453	7.0630	7.0807	7.0984	7.1162	7.1340	7.1518	7.1697	7.1876
148	7.2056	7.2236	7.2416	7.2597	7.2778	7.2959	7.3141	7.3323	7.3506	7.3689
149	7.3872	7.4056	7.4240	7.4424	7.4609	7.4794	7.4980	7.5166	7.5353	7.5540
150	7.5727	7.5915	7.6103	7.6291	7.6480	7.6670	7.6859	7.7049	7.7240	7.7431

SATURATION VAPOR PRESSURE OVER WATER
(°F, in Hg) – TABLE
(continued)

Temperature	English units									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
°F.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.
150	7.5727	7.5915	7.6103	7.6291	7.6480	7.6670	7.6859	7.7049	7.7240	7.7431
151	7.7622	7.7814	7.8005	7.8198	7.8391	7.8584	7.8777	7.8971	7.9166	7.9361
152	7.9556	7.9752	7.9948	8.0145	8.0342	8.0539	8.0737	8.0935	8.1134	8.1333
153	8.1532	8.1732	8.1932	8.2132	8.2333	8.2535	8.2736	8.2939	8.3141	8.3344
154	8.3548	8.3752	8.3956	8.4161	8.4367	8.4572	8.4778	8.4985	8.5192	8.5399
155	8.5607	8.5815	8.6024	8.6233	8.6442	8.6652	8.6862	8.7073	8.7284	8.7496
156	8.7708	8.7921	8.8133	8.8347	8.8561	8.8775	8.8990	8.9205	8.9420	8.9637
157	8.9853	9.0070	9.0287	9.0505	9.0723	9.0942	9.1161	9.1381	9.1601	9.1821
158	9.2042	9.2263	9.2485	9.2707	9.2930	9.3153	9.3377	9.3601	9.3826	9.4051
159	9.4276	9.4502	9.4728	9.4955	9.5182	9.5410	9.5638	9.5867	9.6096	9.6326
160	9.6556	9.6786	9.7017	9.7249	9.7481	9.7713	9.7946	9.8179	9.8413	9.8647
161	9.8882	9.9117	9.9353	9.9589	9.9826	10.006	10.030	10.054	10.078	10.102
162	10.126	10.150	10.174	10.198	10.222	10.246	10.271	10.295	10.319	10.344
163	10.368	10.392	10.417	10.442	10.466	10.491	10.516	10.540	10.565	10.590
164	10.615	10.640	10.665	10.690	10.715	10.740	10.766	10.791	10.816	10.842
165	10.867	10.892	10.918	10.944	10.969	10.995	11.021	11.046	11.072	11.098
166	11.124	11.150	11.176	11.202	11.228	11.254	11.281	11.307	11.333	11.360
167	11.386	11.412	11.439	11.466	11.492	11.519	11.546	11.572	11.599	11.626
168	11.653	11.680	11.707	11.734	11.761	11.788	11.815	11.843	11.870	11.898
169	11.925	11.953	11.980	12.008	12.035	12.063	12.091	12.119	12.147	12.175
170	12.203	12.231	12.259	12.288	12.316	12.344	12.373	12.401	12.430	12.458
171	12.487	12.515	12.544	12.573	12.601	12.630	12.659	12.688	12.717	12.746
172	12.775	12.804	12.834	12.863	12.892	12.922	12.951	12.981	13.011	13.040
173	13.070	13.100	13.130	13.159	13.189	13.219	13.249	13.279	13.310	13.340
174	13.370	13.400	13.431	13.461	13.492	13.522	13.553	13.584	13.614	13.645
175	13.676	13.707	13.738	13.769	13.800	13.831	13.862	13.893	13.924	13.956
176	13.987	14.019	14.050	14.082	14.113	14.145	14.177	14.209	14.241	14.273
177	14.305	14.337	14.369	14.402	14.434	14.466	14.499	14.531	14.564	14.596
178	14.629	14.662	14.695	14.727	14.760	14.793	14.826	14.859	14.893	14.926
179	14.959	14.992	15.026	15.059	15.093	15.126	15.160	15.194	15.227	15.261
180	15.295	15.329	15.363	15.397	15.431	15.465	15.499	15.534	15.568	15.602
181	15.637	15.672	15.706	15.741	15.776	15.811	15.846	15.881	15.916	15.951
182	15.986	16.021	16.056	16.092	16.127	16.163	16.198	16.234	16.269	16.305
183	16.341	16.377	16.413	16.449	16.485	16.521	16.557	16.594	16.630	16.667
184	16.703	16.739	16.776	16.813	16.849	16.886	16.923	16.960	16.997	17.034
185	17.071	17.108	17.145	17.183	17.220	17.258	17.295	17.333	17.370	17.408
186	17.446	17.484	17.522	17.560	17.598	17.637	17.675	17.713	17.752	17.790
187	17.829	17.868	17.906	17.945	17.984	18.023	18.062	18.101	18.140	18.179
188	18.218	18.257	18.297	18.336	18.376	18.415	18.455	18.494	18.534	18.574
189	18.614	18.654	18.694	18.734	18.774	18.814	18.855	18.895	18.936	18.976
190	19.017	19.058	19.099	19.140	19.181	19.222	19.263	19.304	19.345	19.387
191	19.428	19.469	19.511	19.553	19.594	19.636	19.678	19.720	19.762	19.804
192	19.846	19.888	19.930	19.973	20.015	20.058	20.100	20.143	20.185	20.228
193	20.271	20.314	20.357	20.400	20.443	20.486	20.530	20.573	20.617	20.660
194	20.704	20.748	20.792	20.835	20.879	20.924	20.968	21.012	21.056	21.101
195	21.145	21.190	21.234	21.279	21.324	21.369	21.414	21.459	21.504	21.549
196	21.594	21.639	21.684	21.730	21.775	21.821	21.867	21.912	21.958	22.004
197	22.050	22.096	22.142	22.189	22.235	22.282	22.328	22.375	22.421	22.468
198	22.515	22.562	22.609	22.656	22.703	22.750	22.797	22.844	22.892	22.939
199	22.987	23.035	23.083	23.130	23.178	23.226	23.275	23.323	23.371	23.420
200 –	23.468	23.516	23.565	23.614	23.663	23.711	23.760	23.809	23.858	23.908

SATURATION VAPOR PRESSURE OVER WATER
(°F, in Hg) – TABLE

(continued)

Temperature	English units									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
°F.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.	in. Hg.
200	23.468	23.516	23.565	23.614	23.663	23.711	23.760	23.809	23.858	23.908
201	23.957	24.006	24.056	24.106	24.155	24.205	24.255	24.305	24.355	24.405
202	24.455	24.505	24.555	24.606	24.656	24.707	24.758	24.808	24.859	24.910
203	24.961	25.012	25.063	25.115	25.166	25.217	25.269	25.321	25.372	25.424
204	25.476	25.528	25.580	25.632	25.685	25.737	25.789	25.842	25.895	25.947
205	26.000	26.053	26.106	26.159	26.212	26.265	26.318	26.371	26.425	26.478
206	26.532	26.586	26.640	26.694	26.748	26.802	26.856	26.910	26.965	27.019
207	27.074	27.129	27.183	27.238	27.293	27.348	27.404	27.459	27.514	27.569
208	27.625	27.681	27.736	27.792	27.848	27.904	27.960	28.016	28.072	28.129
209	28.185	28.241	28.298	28.355	28.411	28.468	26.525	28.582	28.639	28.697
210	28.754	28.811	28.869	28.927	28.985	29.042	29.100	29.158	29.216	29.275
211	29.333	29.391	29.450	29.508	29.567	29.626	29.685	29.744	29.803	29.862
212	29.921									

SATURATION VAPOR PRESSURE OVER WATER
(°C, MILLIBARS) – TABLE

	Metric units									
Temperature	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
°C.	mb.	mb.	mb.	mb.	mb.	mb.	mb.	mb.	mb.	mb.
0	6.1078	6.1523	6.1971	6.2422	6.2876	6.3333	6.3793	6.4256	6.4721	6.5190
1	6.5662	6.6137	6.6614	6.7095	6.7579	6.8066	6.8556	6.9049	6.9545	7.0044
2	7.0547	7.1053	7.1562	7.2074	7.2590	7.3109	7.3631	7.4157	7.4685	7.5218
3	7.5753	7.6291	7.6833	7.7379	7.7928	7.8480	7.9036	7.9595	8.0158	8.0724
4	8.1294	8.1868	8.2445	8.3026	8.3610	8.4198	8.4789	8.5384	8.5983	8.6586
5	8.7192	8.7802	8.8416	8.9033	8.9655	9.0280	9.0909	9.1542	9.2179	9.2820
6	9.3465	9.4114	9.4766	9.5423	9.6083	9.6748	9.7416	9.8089	9.8765	9.9446
7	10.013	10.082	10.151	10.221	10.291	10.362	10.433	10.505	10.577	10.649
8	10.722	10.795	10.869	10.943	11.017	11.092	11.168	11.243	11.320	11.397
9	11.474	11.552	11.630	11.708	11.787	11.867	11.947	12.027	12.108	12.190
10	12.272	12.355	12.438	12.521	12.606	12.690	12.775	12.860	12.946	13.032
11	13.119	13.207	13.295	13.383	13.472	13.562	13.652	13.742	13.833	13.925
12	14.017	14.110	14.203	14.297	14.391	14.486	14.581	14.678	14.774	14.871
13	14.969	15.067	15.166	15.266	15.365	15.466	15.567	15.669	15.771	15.874
14	15.977	16.081	16.186	16.291	16.397	16.503	16.610	16.718	16.826	16.935
15	17.044	17.154	17.264	17.376	17.487	17.600	17.713	17.827	17.942	18.057
16	18.173	18.290	18.407	18.524	18.643	18.762	18.882	19.002	19.123	19.245
17	19.367	19.490	19.614	19.739	19.864	19.990	20.117	20.244	20.372	20.501
18	20.630	20.760	20.891	21.023	21.155	21.288	21.422	21.556	21.691	21.827
19	21.964	22.101	22.240	22.379	22.518	22.659	22.800	22.942	23.085	23.229
20	23.373	23.518	23.664	23.811	23.959	24.107	24.256	24.406	24.557	24.709
21	24.861	25.014	25.168	25.323	25.479	25.635	25.792	25.950	26.109	26.269
22	26.430	26.592	26.754	26.918	27.082	27.247	27.413	27.580	27.748	27.916
23	28.086	28.256	28.428	28.600	28.773	28.947	29.122	29.298	29.475	29.652
24	29.831	30.011	30.191	30.373	30.555	30.739	30.923	31.109	31.295	31.483
25	31.671	31.860	32.050	32.242	32.434	32.627	32.821	33.016	33.212	33.410
26	33.608	33.807	34.008	34.209	34.411	34.615	34.820	35.025	35.232	35.440
27	35.649	35.859	36.070	36.282	36.495	36.709	36.924	37.140	37.358	37.576
28	37.796	38.017	38.239	38.462	38.686	38.911	39.137	39.365	39.594	39.824
29	40.055	40.287	40.521	40.755	40.991	41.228	41.466	41.705	41.945	42.187
30	42.430	42.674	42.919	43.166	43.414	43.663	43.913	44.165	44.418	44.672
31	44.927	45.184	45.442	45.701	45.961	46.223	46.486	46.750	47.016	47.283
32	47.551	47.820	48.091	48.364	48.637	48.912	49.188	49.466	49.745	50.025
33	50.307	50.590	50.874	51.160	51.447	51.736	52.026	52.317	52.610	52.904
34	53.200	53.497	53.796	54.096	54.397	54.700	55.004	55.310	55.617	55.926
35	56.236	56.548	56.861	57.176	57.492	57.810	58.129	58.450	58.773	59.097
36	59.422	59.749	60.077	60.407	60.739	61.072	61.407	61.743	62.081	62.421
37	62.762	63.105	63.450	63.796	64.144	64.493	64.844	65.196	65.550	65.906
38	66.264	66.623	66.985	67.347	67.712	68.078	68.446	68.815	69.186	69.559
39	69.934	70.310	70.688	71.068	71.450	71.833	72.218	72.605	72.994	73.385
40	73.777	74.171	74.568	74.966	75.365	75.767	76.170	76.575	76.982	77.391
41	77.802	78.215	78.630	79.046	79.465	79.885	80.307	80.731	81.157	81.585
42	82.015	82.447	82.881	83.316	83.754	84.194	84.636	85.079	85.525	85.973
43	86.423	86.875	87.329	87.785	88.243	88.703	89.165	89.629	90.095	90.564
44	91.034	91.507	91.981	92.458	92.937	93.418	93.901	94.386	94.874	95.363
45	95.855	96.349	96.845	97.343	97.844	98.347	98.852	99.359	99.869	100.38
46	100.89	101.41	101.93	102.45	102.97	103.50	104.03	104.56	105.09	105.62
47	106.16	106.70	107.24	107.78	108.33	108.88	109.43	109.98	110.54	111.10
48	111.66	112.22	112.79	113.36	113.93	114.50	115.07	115.65	116.23	116.81
49	117.40	117.99	118.58	119.17	119.77	120.37	120.97	121.57	122.18	122.79
50	123.40	124.01	124.63	125.25	125.87	126.49	127.12	127.75	128.38	129.01

See Reference No. 1

SATURATION VAPOR PRESSURE OVER WATER
(°C, MILLIBARS) – TABLE

(continued)

Temperature	Metric units									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
°C.	mb.	mb.	mb.	mb.	mb.	mb.	mb.	mb.	mb.	mb.
50	123.40	124.01	124.63	125.25	125.87	126.49	127.12	127.75	128.38	129.01
51	129.65	130.29	130.93	131.58	132.23	132.88	133.53	134.19	134.84	135.51
52	136.17	136.84	137.51	138.18	138.86	139.54	140.22	140.91	141.60	142.29
53	142.98	143.68	144.38	145.08	145.78	146.49	147.20	147.91	148.63	149.35
54	150.07	150.80	151.53	152.26	152.99	153.73	154.47	155.21	155.96	156.71
55	157.46	158.22	158.97	159.74	160.50	161.27	162.04	162.82	163.59	164.38
56	165.16	165.95	166.74	167.53	168.33	169.13	169.93	170.74	171.55	172.36
57	173.18	174.00	174.82	175.65	176.48	177.31	178.15	178.99	179.83	180.68
58	181.53	182.38	183.24	184.10	184.96	185.83	186.70	187.58	188.45	189.34
59	190.22	191.11	192.00	192.89	193.79	194.69	195.60	196.51	197.42	198.34
60	199.26	200.18	201.11	202.05	202.98	203.92	204.86	205.81	206.76	207.71
61	208.67	209.63	210.59	211.56	212.53	213.51	214.49	215.48	216.46	217.45
62	218.45	219.45	220.45	221.46	222.47	223.48	224.50	225.52	226.54	227.58
63	228.61	229.65	230.70	231.74	232.79	233.85	234.91	235.97	237.03	238.11
64	239.18	240.26	241.34	242.43	243.52	244.62	245.72	246.82	247.93	249.04
65	250.16	251.28	252.41	253.54	254.67	255.81	256.95	258.10	259.25	260.40
66	261.56	262.73	263.90	265.07	266.25	267.43	268.61	269.80	271.00	272.20
67	273.40	274.61	275.82	277.04	278.26	279.49	280.72	281.96	283.20	284.45
68	285.70	286.96	288.21	289.48	290.75	292.02	293.30	294.58	295.86	297.15
69	298.45	299.75	301.06	302.37	303.69	305.01	306.34	307.67	309.00	310.34
70	311.69	313.04	314.39	315.75	317.12	318.49	319.87	321.25	322.63	324.02
71	325.42	326.82	328.22	329.63	331.05	332.47	333.89	335.33	336.76	338.20
72	339.65	341.10	342.56	344.03	345.50	346.97	348.45	349.93	351.42	352.91
73	354.41	355.91	357.43	358.94	360.46	361.99	363.52	365.06	366.61	368.15
74	369.71	371.27	372.84	374.41	375.99	377.57	379.16	380.75	382.35	383.95
75	385.56	387.18	388.80	390.43	392.06	393.70	395.34	396.99	398.65	400.31
76	401.98	403.65	405.34	407.02	408.71	410.41	412.11	413.82	415.53	417.25
77	418.98	420.71	422.45	424.20	425.95	427.71	429.47	431.24	433.02	434.80
78	436.59	438.38	440.18	441.99	443.80	445.62	447.45	449.28	451.11	452.96
79	454.81	456.67	458.53	460.40	462.28	464.16	466.05	467.94	469.85	471.76
80	473.67	475.59	477.52	479.45	481.39	483.34	485.29	487.25	489.22	491.19
81	493.17	495.16	497.15	499.16	501.17	503.18	505.20	507.23	509.26	511.30
82	513.35	515.41	517.47	519.54	521.62	523.70	525.79	527.89	529.99	532.10
83	534.22	536.35	538.48	540.62	542.77	544.92	547.08	549.25	551.43	553.61
84	555.80	557.99	560.20	562.41	564.62	566.85	569.08	571.32	573.57	575.83
85	578.09	580.36	582.64	584.93	587.22	589.52	591.83	594.14	596.46	598.79
86	601.13	603.48	605.83	608.19	610.56	612.94	615.32	617.72	620.12	622.52
87	624.94	627.36	629.79	632.23	634.68	637.13	639.59	642.07	644.55	647.03
88	649.53	652.03	654.54	657.06	659.59	662.12	664.66	667.22	669.78	672.34
89	674.92	677.50	680.09	682.69	685.30	687.92	690.55	693.18	695.82	698.47
90	701.13	703.80	706.47	709.16	711.85	714.55	717.26	719.98	722.71	725.45
91	728.19	730.94	733.70	736.47	739.25	742.04	744.84	747.64	750.46	753.28
92	756.11	758.95	761.80	764.66	767.52	770.40	773.29	776.18	779.09	782.00
93	784.92	787.85	790.79	793.74	796.69	799.66	802.63	805.62	808.61	811.62
94	814.63	817.65	820.69	823.73	826.78	829.84	832.91	835.99	839.08	842.17
95	845.28	848.40	851.52	854.66	857.80	860.96	864.12	867.30	870.48	873.68
96	876.88	880.09	883.31	886.55	889.79	893.04	896.30	899.57	902.86	906.15
97	909.45	912.76	916.08	919.42	922.76	926.11	929.47	932.84	936.23	939.62
98	943.02	946.43	949.85	953.28	956.73	960.18	963.65	967.12	970.61	974.10
99	977.61	981.13	984.65	988.19	991.74	995.30	998.87	1002.45	1006.04	1009.64
100	1013.25	1016.87	1020.50	1024.14	1027.80	1031.46	1035.13	1038.82	1042.51	1046.22
101	1049.94	1053.67	1057.41	1061.16	1064.93	1068.70	1072.49	1076.28	1080.09	1083.91
102	1087.74									

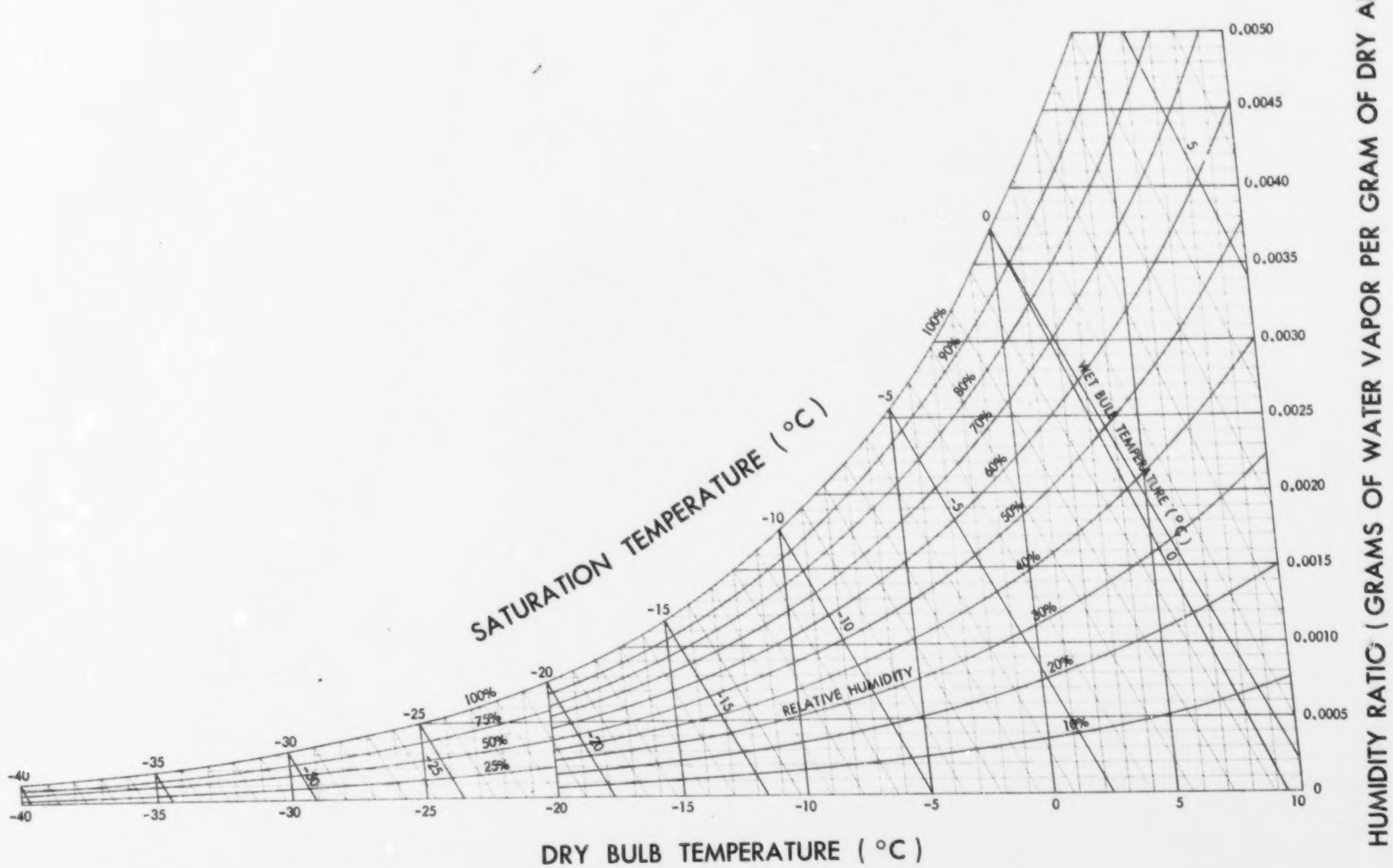
SATURATION VAPOR PRESSURE OVER WATER (°C, mm. Hg) – TABLE

VALUES FOR FRACTIONAL DEGREE BETWEEN 50 AND
89 WERE OBTAINED BY INTERPOLATION

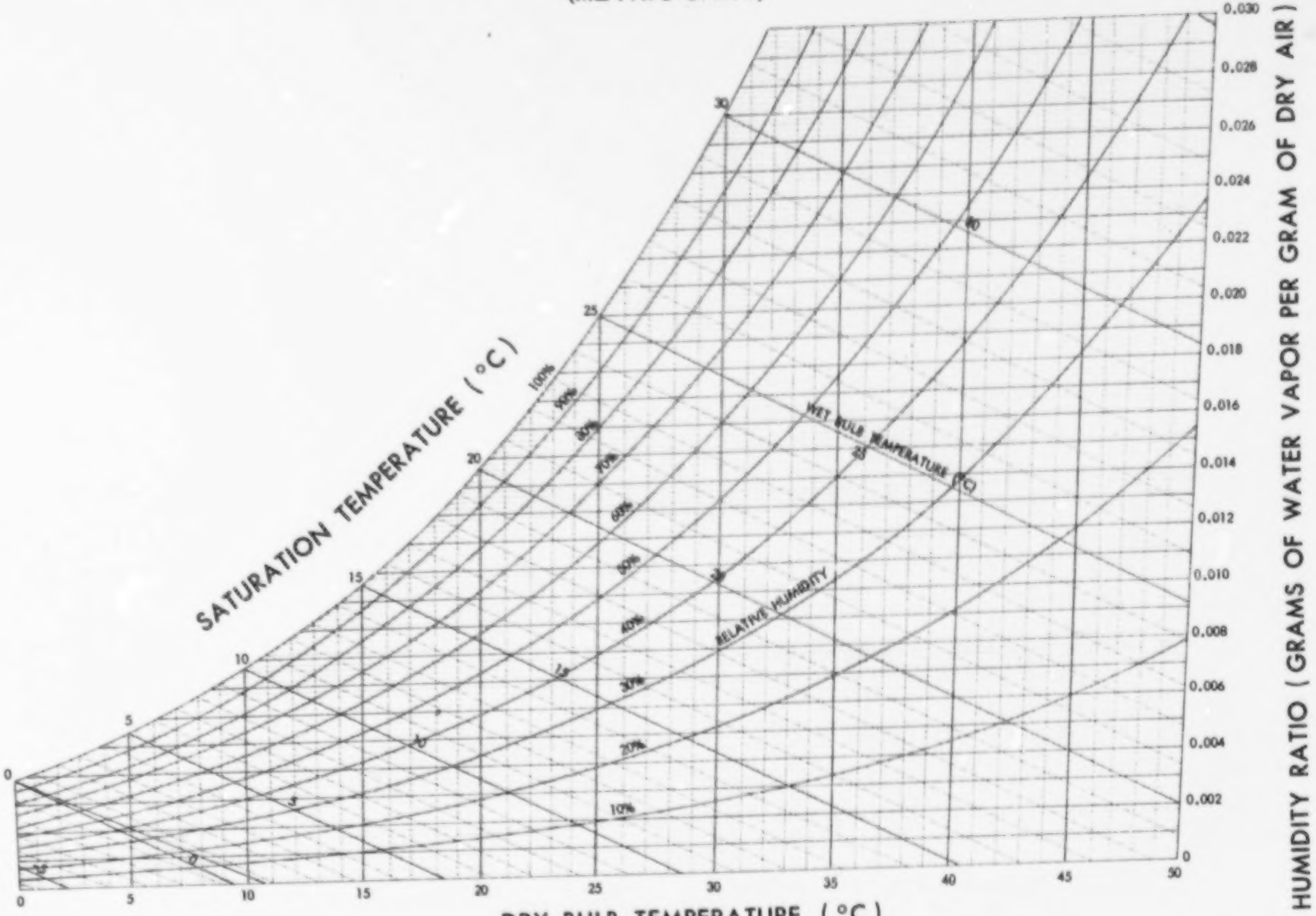
Temp. °C	0.0	0.2	0.4	0.6	0.8
−15	1.436	1.414	1.390	1.368	1.345
−14	1.560	1.534	1.511	1.485	1.460
−13	1.691	1.665	1.637	1.611	1.585
−12	1.834	1.804	1.776	1.748	1.720
−11	1.987	1.955	1.924	1.893	1.863
−10	2.149	2.116	2.084	2.050	2.018
− 9	2.326	2.289	2.254	2.219	2.184
− 8	2.514	2.475	2.437	2.399	2.362
− 7	2.715	2.674	2.633	2.593	2.553
− 6	2.931	2.887	2.843	2.800	2.757
− 5	3.163	3.115	3.069	3.022	2.976
− 4	3.410	3.359	3.309	3.259	3.211
− 3	3.673	3.620	3.567	3.514	3.461
− 2	3.956	3.898	3.841	3.785	3.730
− 1	4.258	4.196	4.135	4.075	4.016
− 0	4.579	4.513	4.448	4.385	4.320
0	4.579	4.647	4.715	4.785	4.855
1	4.926	4.998	5.070	5.144	5.219
2	5.294	5.370	5.447	5.525	5.605
3	5.685	5.766	5.848	5.931	6.015
4	6.101	6.187	6.274	6.363	6.453
5	6.543	6.635	6.728	6.822	6.917
6	7.013	7.111	7.209	7.309	7.411
7	7.513	7.617	7.722	7.828	7.936
8	8.045	8.155	8.267	8.380	8.494
9	8.609	8.727	8.845	8.965	9.086
10	9.209	9.333	9.458	9.585	9.714
11	9.844	9.976	10.109	10.244	10.380
12	10.518	10.658	10.799	10.941	11.085
13	11.231	11.379	11.528	11.680	11.833
14	11.987	12.144	12.302	12.462	12.624
15	12.788	12.953	13.121	13.290	13.461
16	13.634	13.809	13.987	14.166	14.347
17	14.530	14.715	14.903	15.092	15.284
18	15.477	15.673	15.871	16.071	16.272
19	16.477	16.685	16.894	17.105	17.319
20	17.535	17.753	17.974	18.197	18.422
21	18.650	18.880	19.113	19.349	19.587
22	19.827	20.070	20.316	20.565	20.815
23	21.068	21.324	21.583	21.845	22.110
24	22.377	22.648	22.922	23.198	23.476
25	23.756	24.039	24.326	24.617	24.912
26	25.209	25.509	25.812	26.117	26.426
27	26.739	27.055	27.374	27.696	28.021
28	28.349	28.680	29.015	29.354	29.697
29	30.043	30.392	30.745	31.102	31.461
30	31.824	32.191	32.561	32.934	33.312
31	33.695	34.082	34.471	34.864	35.261
32	35.663	36.068	36.477	36.891	37.308
33	37.729	38.155	38.584	39.018	39.457
34	39.898	40.344	40.796	41.251	41.710
35	42.175	42.644	43.117	43.595	44.078
36	44.563	45.054	45.549	46.050	46.556
37	47.067	47.582	48.102	48.627	49.157
38	49.692	50.231	50.774	51.323	51.879
39	52.442	53.009	53.580	54.156	54.737
40	55.324	55.91	56.51	57.11	57.72
41	58.34	58.96	59.58	60.22	60.86
42	61.50	62.14	62.80	63.46	64.12
43	64.80	65.48	66.16	66.86	67.56
44	68.26	68.97	69.69	70.41	71.14
45	71.88	72.62	73.36	74.12	74.88
46	75.65	76.43	77.21	78.00	78.80
47	79.60	80.41	81.23	82.05	82.87
48	83.71	84.56	85.42	86.28	87.14
49	88.02	88.90	89.79	90.69	91.59
50	92.51	93.5	94.4	95.3	96.3
51	97.20	98.2	99.1	100.1	101.1
52	102.09	103.1	104.1	105.1	106.2
53	107.20	108.2	109.3	110.4	111.4
54	112.51	113.6	114.7	115.8	116.9
55	118.04	119.1	120.3	121.5	122.6
56	123.80	125.0	126.2	127.4	128.6
57	129.82	131.0	132.3	133.5	134.7
58	136.08	137.3	138.5	139.9	141.2
59	142.60	143.9	145.2	146.6	148.0
60	149.38	150.7	152.1	153.5	155.0
61	156.43	157.8	159.3	160.8	162.3
62	163.77	165.2	166.8	168.3	169.8
63	171.38	172.9	174.5	176.1	177.7
64	179.31	180.9	182.5	184.2	185.8
65	187.54	189.2	190.9	192.6	194.3
66	196.09	197.8	199.5	201.3	203.1
67	204.96	206.8	208.6	210.5	212.3
68	214.17	216.0	218.0	219.9	221.8
69	223.73	225.7	227.7	229.7	231.7
70	233.7	235.7	237.7	239.7	241.8
71	243.9	246.0	248.2	250.3	252.4
72	254.6	256.8	259.0	261.2	263.4
73	265.7	268.0	270.2	272.6	274.8
74	277.2	279.4	281.8	284.2	286.6
75	289.1	291.5	294.0	296.4	298.8
76	301.4	303.8	306.4	308.9	311.4
77	314.1	316.6	319.2	322.0	324.6
78	327.3	330.0	332.8	335.6	338.2
79	341.0	343.8	346.6	349.4	352.2
80	355.1	358.0	361.0	363.8	366.8
81	369.7	372.6	375.6	378.8	381.8
82	384.9	388.0	391.2	394.4	397.4
83	400.6	403.8	407.0	410.2	413.6
84	416.8	420.2	423.6	426.8	430.2
85	433.6	437.0	440.4	444.0	447.5
86	450.9	454.4	458.0	461.6	465.2
87	468.7	472.4	476.0	479.8	483.4
88	487.1	491.0	494.7	498.5	502.2
89	506.1	510.0	513.9	517.8	521.8
90	525.76	529.77	533.80	537.86	541.95
91	546.05	550.18	554.35	558.53	562.75
92	566.99	571.26	575.55	579.87	584.22
93	588.60	593.00	597.43	601.89	606.38
94	610.90	615.44	620.01	624.61	629.24
95	633.90	638.59	643.30	648.05	652.82
96	657.62	662.45	667.31	672.20	677.12
97	682.07	687.04	692.05	697.10	702.17
98	707.27	712.40	717.56	722.75	727.98
99	733.24	738.53	743.85	749.20	754.58
100	760.00	765.45	770.93	776.44	782.00
101	787.57	793.18	798.82	804.50	810.21

See Reference No. 12

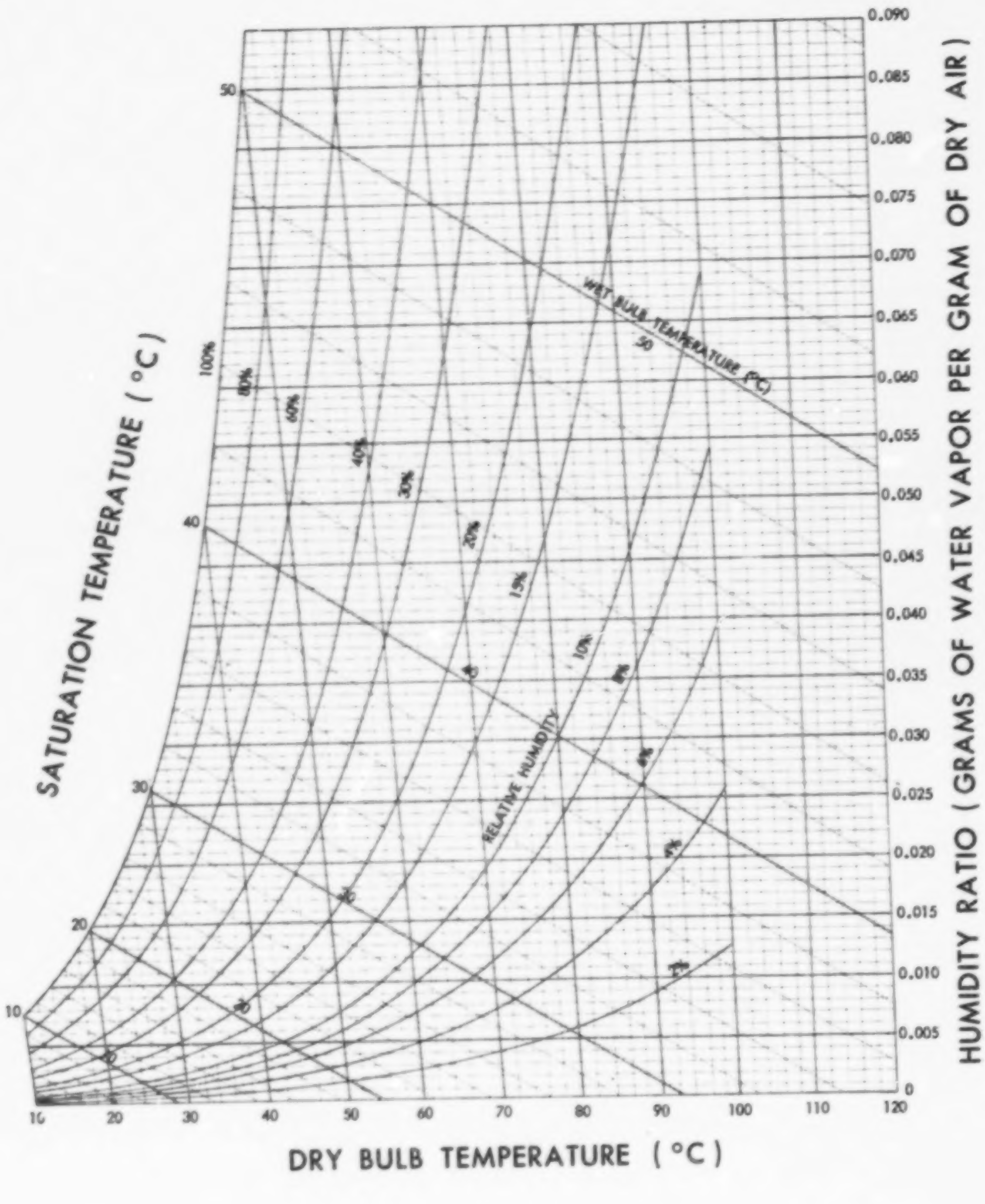
LOW TEMPERATURE PSYCHROMETRIC CHART
(METRIC UNITS)



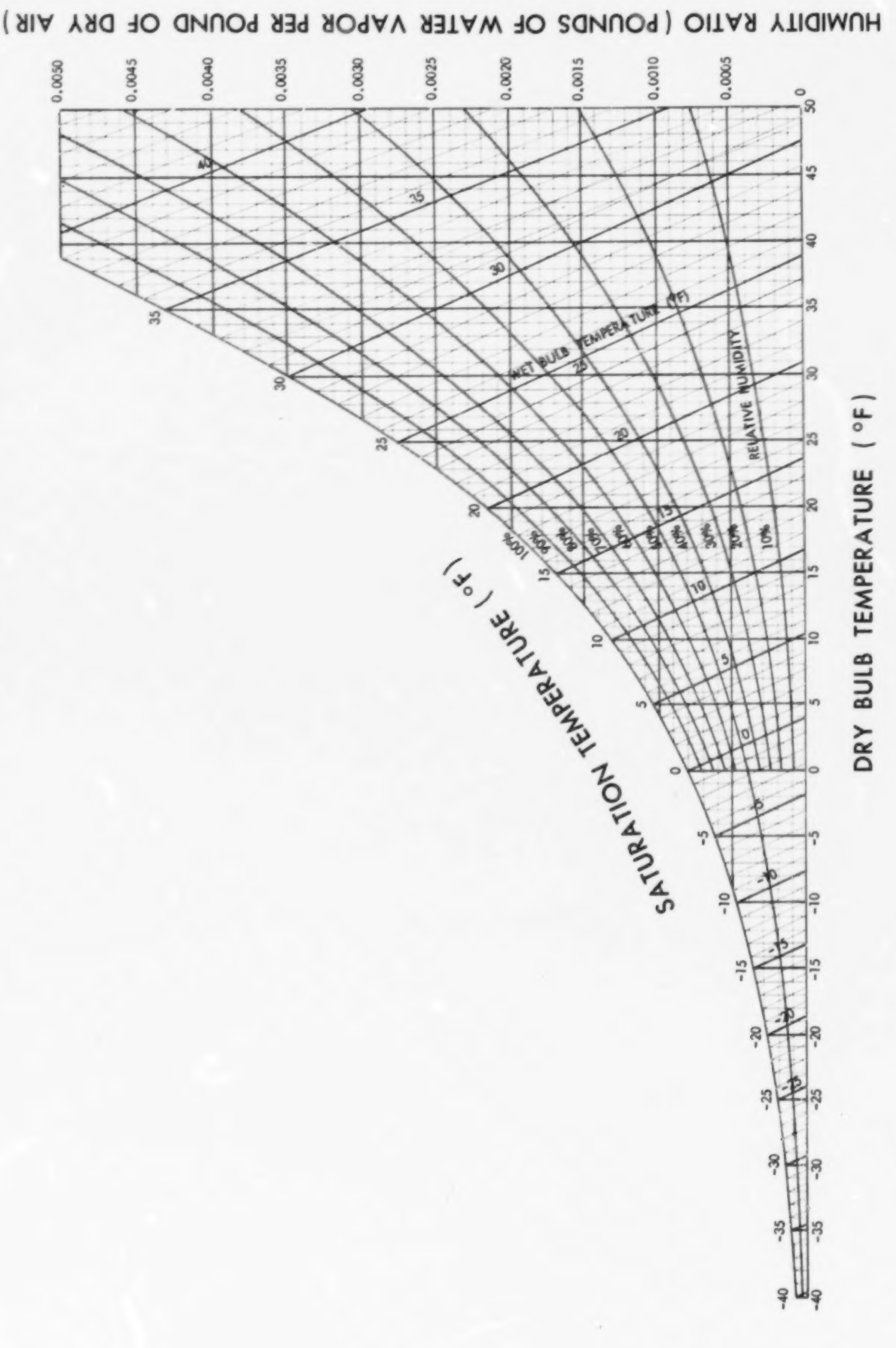
NORMAL TEMPERATURE PSYCHROMETRIC CHART
(METRIC UNITS)



HIGH TEMPERATURE PSYCHROMETRIC CHART
(METRIC UNITS)

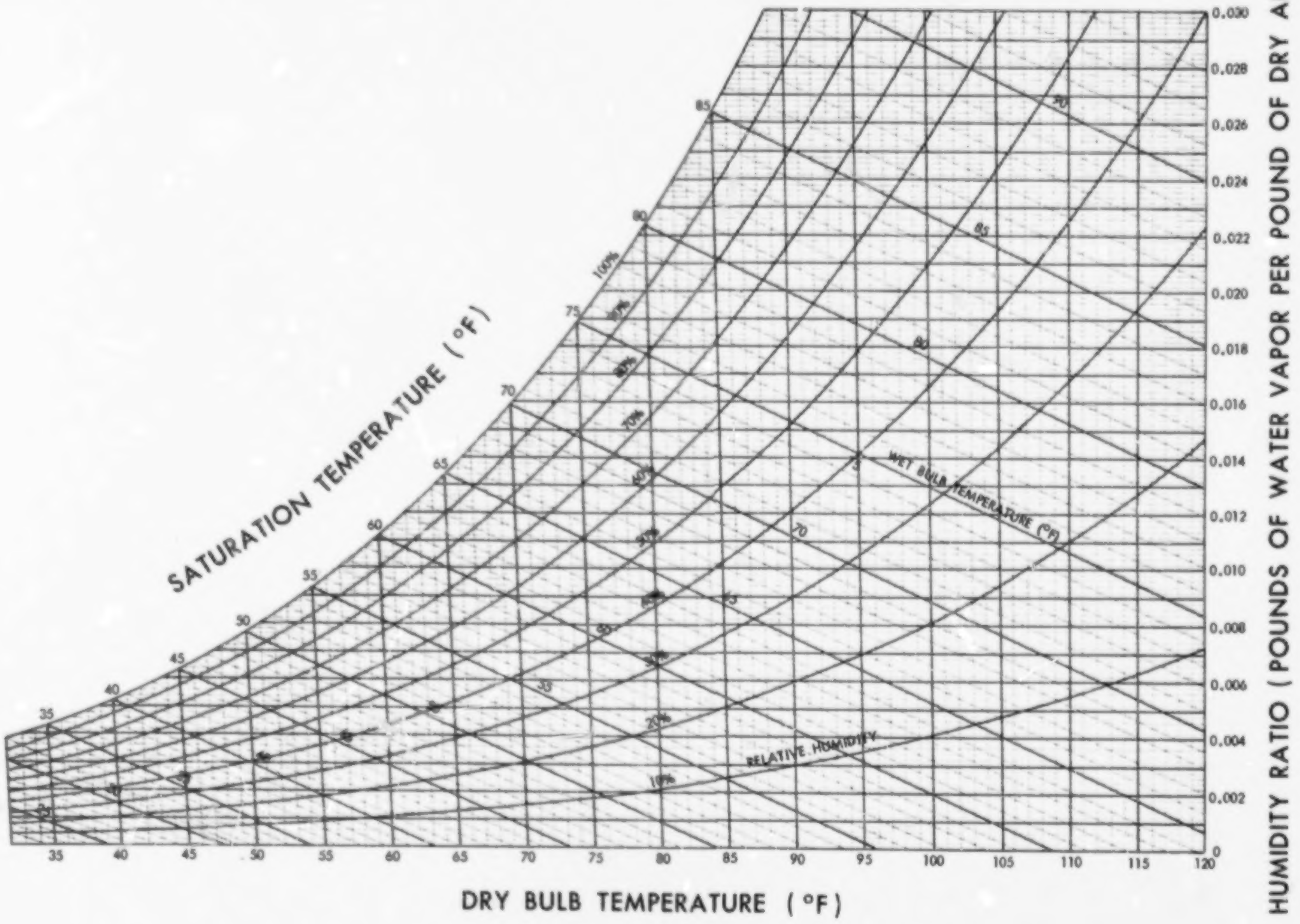


LOW TEMPERATURE PSYCHROMETRIC CHART
(ENGLISH UNITS)



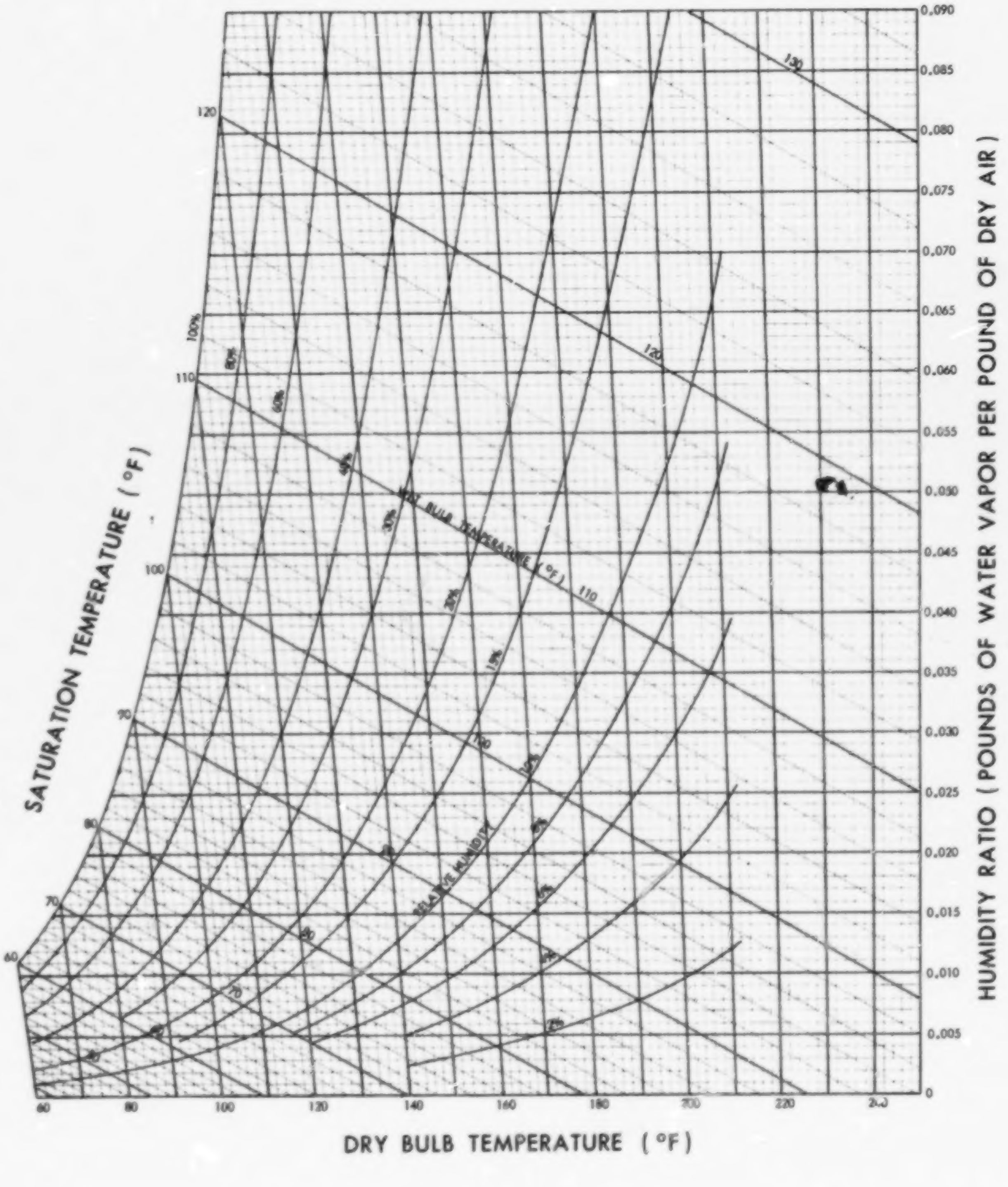
See Reference No. 14

NORMAL TEMPERATURE PSYCHROMETRIC CHART
(ENGLISH UNITS)



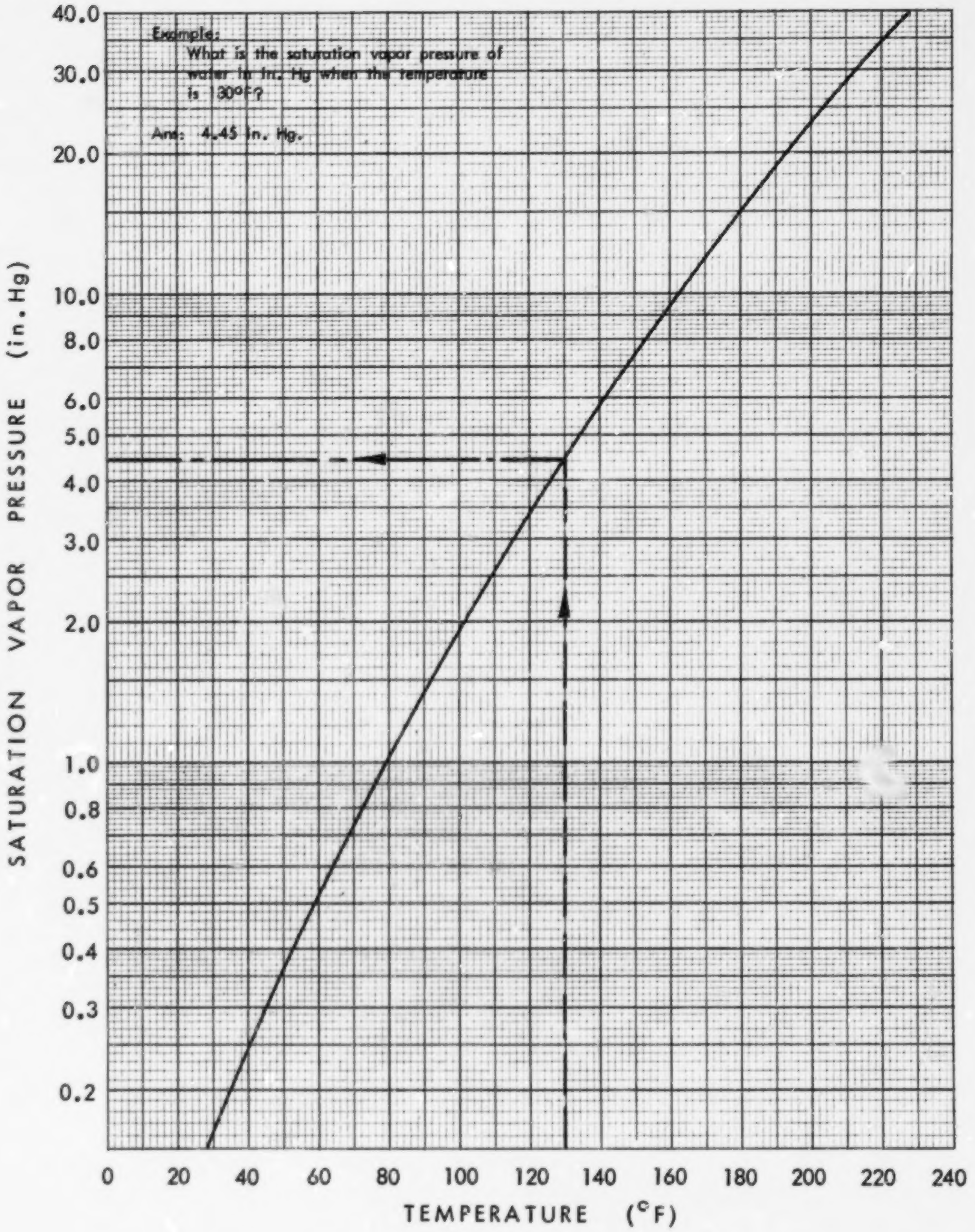
See Reference No. 14

HIGH TEMPERATURE PSYCHROMETRIC CHART
(ENGLISH UNITS)



See *Reference* No. 14

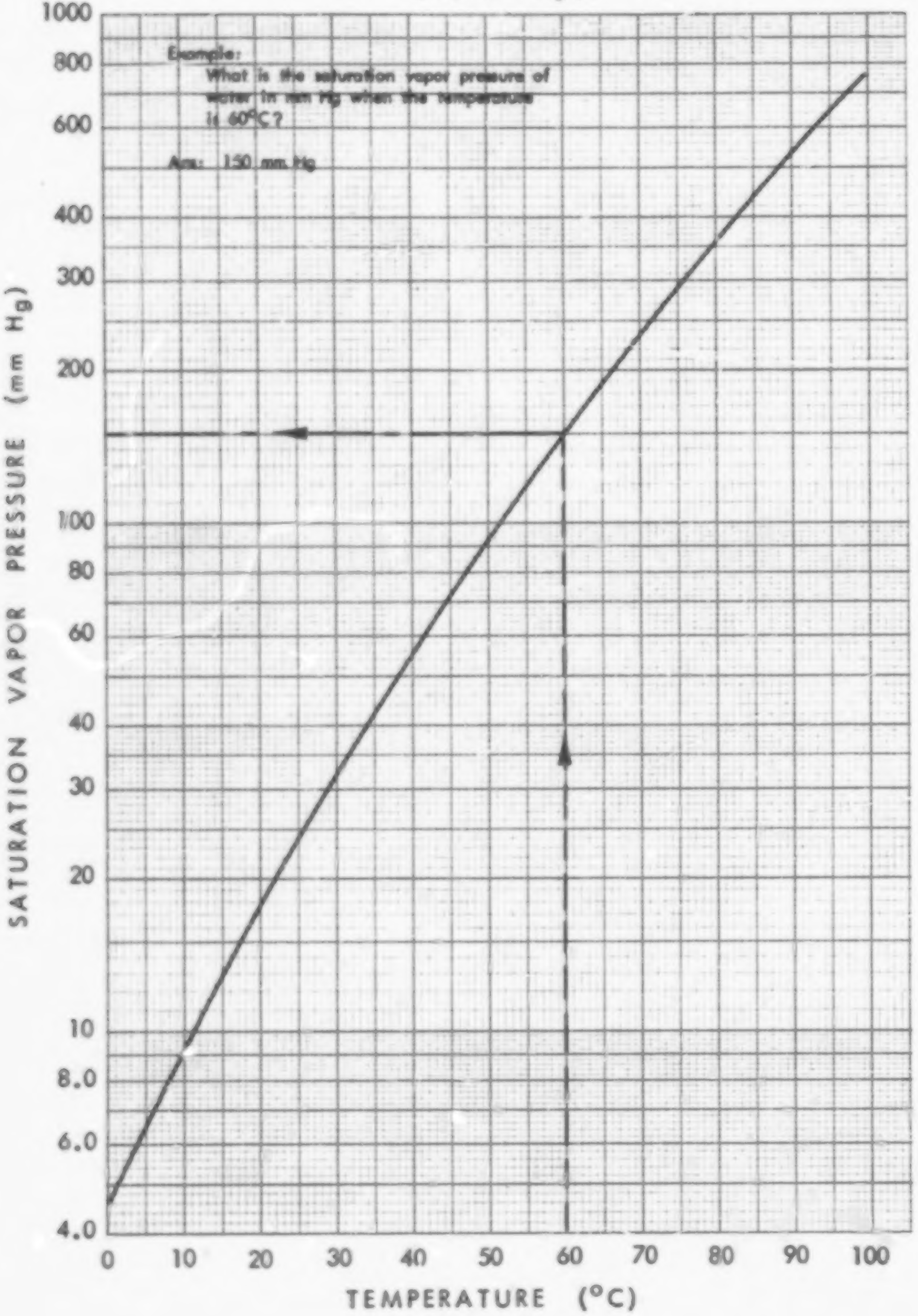
SATURATION VAPOR PRESSURE OVER WATER
(°F, in. Hg)



Example:
What is the saturation vapor pressure of water in in. Hg when the temperature is 130°F?

Ans: 4.45 in. Hg.

SATURATION VAPOR PRESSURE OVER WATER
(°C, mm. Hg.)



Example:
What is the saturation vapor pressure of water in mm Hg when the temperature is 60°C?

Ans: 150 mm Hg

REDUCTION OF PSYCHROMETRIC OBSERVATIONS (FAHRENHEIT TEMPERATURES)

Values of $\Delta e = 0.000367 p (t - t') \left(1 + \frac{t' - 32}{1571}\right)$ for $p = 30$ in. Hg. and 1 in. Hg.

(See p. 365 for discussion and explanation of table.)

Depression of wet bulb $t - t'$ °F.	Wet-bulb temperature t' — °F. 0		20		40		60		80		°F.
	30 in. in. Hg.	1 in. in. Hg	30 in. in. Hg.	1 in. in. Hg.	30 in. in. Hg.	1 in. in. Hg.	30 in. in. Hg.	1 in. in. Hg.	30 in. in. Hg.	1 in. in. Hg.	
1	0.01079	0.00036	0.01093	0.00037	0.01107	0.00037	0.01121	0.00038	0.01135	0.00038	1
2	.02157	.00072	.02185	.00072	.02213	.00073	.02241	.00074	.02269	.00075	2
3	.03236	.00108	.03278	.00109	.03320	.00111	.03362	.00112	.03404	.00113	3
4	.04314	.00144	.04370	.00146	.04426	.00148	.04482	.00150	.04539	.00151	4
5	0.05393	0.00180	0.05463	0.00183	0.05533	0.00185	0.05603	0.00187	0.05673	0.00190	5
6	.06471	.00216	.06556	.00218	.06640	.00221	.06724	.00224	.06808	.00227	6
7	.07550	.00252	.07648	.00255	.07746	.00258	.07844	.00262	.07942	.00265	7
8	.08629	.00288	.08741	.00292	.08853	.00295	.08965	.00299	.09077	.00303	8
9	.09707	.00323	.09833	.00327	.09959	.00332	.10086	.00336	.10212	.00340	9
10			0.10926	0.00364	0.11066	0.00369	0.11206	0.00374	0.11346	0.00378	10
11			.12018	.00401	.12173	.00406	.12327	.00411	.12481	.00416	11
12					.13279	.00442	.13447	.00448	.13616	.00453	12
13					.14386	.00479	.14568	.00486	.14750	.00492	13
14					.15492	.00517	.15689	.00523	.15885	.00530	14
15					0.16599	0.00553	0.16809	0.00560	0.17020	0.00567	15
16					.17706	.00590	.17930	.00597	.18154	.00605	16
17					.18812	.00627	.19051	.00635	.19289	.00643	17
18					.19919	.00664	.20171	.00673	.20423	.00681	18
19					.21025	.00701	.21292	.00709	.21558	.00718	19
20					0.22132	0.00738	0.22412	0.00747	0.22693	0.00756	20
21					.23239	.00775	.23533	.00785	.23827	.00795	21
22							.24654	.00821	.24962	.00832	22
23							.25774	.00859	.26097	.00870	23
24							.26895	.00897	.27231	.00908	24
25							0.28015	0.00934	0.28366	0.00946	25
26							.29136	.00971	.29501	.00983	26
27							.30257	.01009	.30635	.01021	27
28							.31377	.01046	.31770	.01059	28
29							.32498	.01083	.32904	.01097	29
30							0.33619	0.01121	0.34039	0.01135	30
							.34739	.01158	.35174	.01173	31
							.35860	.01195	.36308	.01210	32
							.36980	.01233	.37443	.01248	33
							.38101	.01270	.38578	.01286	34
							0.39222	0.01307	0.39712	0.01323	35
							.40342	.01345	.40847	.01361	36
							.41463	.01382	.41982	.01399	37
							.42584	.01420	.43116	.01438	38
							.43704	.01456	.44251	.01475	39
							0.44825	0.01494	0.45385	0.01513	40
							.45945	.01532	.46520	.01551	41
							.47066	.01568	.47655	.01588	42
							.48187	.01606	.48789	.01626	43
							.49307	.01644	.49924	.01664	44
							0.50428	0.01681	0.51059	0.01702	45
							.51549	.01718	.52193	.01740	46
							.52669	.01756	.53328	.01778	47
									.54463	.01816	48
									.55597	.01853	49
									0.56732	0.01891	50

Depression of wet bulb $t - t'$ °F.	Wet-bulb temperature t' — °F. —40		—20	
	30 in. in. Hg.	1 in. in. Hg.	30 in. in. Hg.	1 in. in. Hg.
1	0.010505	0.000353	0.010646	0.000358
2	.021011	.000697	.021291	.000706
3	.031516	.001050	.031937	.001064
4	.042022	.001403	.042582	.001421
5	0.052527	0.001756	0.053228	0.001779
6	.063032	.002099	.063873	.002127
7	.073538	.002452	.074519	.002485
8	.084043	.002805	.085165	.002843
9	.094549	.003149	.095810	.003191

REDUCTION OF PSYCHROMETRIC OBSERVATIONS
(CENTIGRADE TEMPERATURES)

Values of $\Delta e = 0.000660(1 + 0.00115t')p(t - t')$ for $p = 1000$ mb.

Depression of wet bulb $t - t'$	Wet-bulb temperature t' — °C.										
	−50	−40	−30	−20	−10	0	10	20	30	40	50
°C.	mb.	mb.	mb.	mb.	mb.	mb.	mb.	mb.	mb.	mb.	mb.
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.6220	0.6296	0.6372	0.6448	0.6524	0.6600	0.6676	0.675	0.683	0.690	0.698
2	1.2441	1.2593	1.2745	1.2896	1.3048	1.3200	1.3352	1.350	1.366	1.381	1.396
3	1.8662	1.8889	1.9117	1.9345	1.9572	1.9800	2.0028	2.026	2.048	2.071	2.094
4	2.4882	2.5186	2.5489	2.5793	2.6096	2.6400	2.6704	2.701	2.731	2.761	2.792
5	3.1102	3.1482	3.1862	3.2241	3.2620	3.3000	3.3380	3.376	3.414	3.452	3.490
6	3.7323	3.7778	3.8234	3.8689	3.9145	3.9600	4.0055	4.051	4.097	4.142	4.188
7	4.3544	4.4075	4.4606	4.5137	4.5669	4.6200	4.6731	4.726	4.779	4.833	4.886
8	4.9764	5.0371	5.0978	5.1586	5.2193	5.2800	5.3407	5.401	5.462	5.523	5.584
9	5.5984	5.6668	5.7351	5.8034	5.8717	5.9400	6.0083	6.077	6.145	6.213	6.282
10						6.6000	6.6759	6.752	6.828	6.904	6.980
11							7.3435	7.427	7.510	7.594	7.677
12							8.0111	8.102	8.193	8.284	8.375
13							8.6787	8.777	8.876	8.975	9.073
14							9.3463	9.453	9.559	9.665	9.771
15							10.0138	10.128	10.242	10.355	10.469
16							10.6814	10.803	10.924	11.046	11.167
17							11.3490	11.478	11.607	11.736	11.865
18							12.0166	12.153	12.290	12.426	12.563
19							12.6842	12.828	12.973	13.117	13.261
20								13.504	13.655	13.807	13.959
21								14.179	14.338	14.498	14.657
22								14.854	15.021	15.188	15.355
23								15.529	15.704	15.878	16.053
24								16.204	16.386	16.569	16.751
25								16.880	17.069	17.259	17.449
26								17.555	17.752	17.949	18.147
27								18.230	18.435	18.640	18.845
28								18.905	19.118	19.330	19.543
29								19.580	19.800	20.020	20.241
30								20.255	20.483	20.711	20.938
31								20.931	21.166	21.401	21.636
32								21.606	21.849	22.092	22.334
33								22.281	22.531	22.782	23.032
34								22.956	23.214	23.472	23.730
35								23.631	23.897	24.163	24.428

See Reference No. 1

CORRECTION TABLES FOR PSYCHROMETRIC CHART – ALTITUDE – (FAHRENHEIT)

Additive Corrections for W, h, and v When Barometric Pressure Differs from Standard Barometer

Approximate altitude in feet

Wet Bulb Temp. t'	Sat. Vapor Press. In. Hg	−900		900		1800		2700		3700		4800		5900	
		Δp = +1		Δp = −1		Δp = −2		Δp = −3		Δp = −4		Δp = −5		Δp = −6	
		ΔW_s[1]	Δh	ΔW_s[1]	Δh	ΔW_s[1]	Δh	ΔW_s[1]	Δh	ΔW_s[1]	Δh	ΔW_s[1]	Δh	ΔW_s[1]	Δh
−20	0.013	−0.06	−0.01	0.06	0.01	0.13	0.02	0.20	0.03	0.28	0.04	0.36	0.05	0.47	0.07
−18	0.014	−0.07	−0.01	0.07	0.01	0.14	0.02	0.23	0.03	0.32	0.05	0.41	0.06	0.52	0.08
−16	0.016	−0.07	−0.01	0.08	0.01	0.16	0.02	0.26	0.04	0.36	0.05	0.46	0.07	0.58	0.09
−14	0.018	−0.08	−0.01	0.09	0.01	0.18	0.03	0.29	0.04	0.40	0.06	0.52	0.08	0.65	0.10
−12	0.020	−0.09	−0.01	0.10	0.01	0.21	0.03	0.32	0.05	0.44	0.07	0.58	0.09	0.72	0.11
−10	0.022	−0.10	−0.02	0.11	0.02	0.23	0.03	0.36	0.05	0.50	0.07	0.64	0.10	0.81	0.12
−8	0.025	−0.12	−0.02	0.12	0.02	0.26	0.04	0.40	0.06	0.55	0.08	0.72	0.11	0.90	0.13
−6	0.027	−0.13	−0.02	0.14	0.02	0.29	0.04	0.44	0.07	0.62	0.09	0.80	0.12	1.00	0.15
−4	0.030	−0.14	0.02	0.15	0.02	0.32	0.05	0.50	0.07	0.69	0.10	0.89	0.13	1.12	0.17
−2	0.034	−0.16	−0.12	0.17	0.02	0.35	0.05	0.55	0.08	0.76	0.11	0.99	0.15	1.24	0.19
0	0.038	−0.18	[illegible]	0.19	0.03	0.39	0.06	0.61	0.09	0.85	0.13	1.10	0.17	1.38	0.21
2	0.042	−0.20	[illegible]	0.21	0.03	0.44	0.07	0.68	0.10	0.94	0.14	1.22	0.19	1.53	0.23
4	0.046	−0.22	−0.03	0.23	0.03	0.48	0.07	0.75	0.11	1.05	0.16	1.36	0.21	1.70	0.26
6	0.051	−0.24	−0.04	0.26	0.04	0.54	0.08	0.83	0.13	1.16	0.18	1.51	0.23	1.89	0.29
8	0.057	−0.27	−0.04	0.29	0.04	0.59	0.09	0.93	0.14	1.28	0.19	1.67	0.25	2.09	0.32
10	0.063	−0.30	−0.04	0.32	0.05	0.66	0.10	1.03	0.16	1.42	0.22	1.85	0.28	2.31	0.35
12	0.069	−0.33	−0.05	0.35	0.05	0.73	0.11	1.13	0.17	1.57	0.24	2.04	0.31	2.56	0.39
14	0.077	−0.36	−0.05	0.39	0.06	0.81	0.12	1.25	0.19	1.74	0.26	2.26	0.34	2.82	0.43
16	0.085	−0.40	−0.06	0.43	0.06	0.89	0.14	1.38	0.21	1.92	0.29	2.49	0.38	3.12	0.48
18	0.093	−0.44	−0.07	0.47	0.07	0.98	0.15	1.53	0.23	2.12	0.32	2.75	0.42	3.44	0.53
20	0.103	−0.49	−0.08	0.52	0.08	1.08	0.17	1.68	0.26	2.33	0.36	3.03	0.46	3.79	0.58
22	0.113	−0.5	−0.08	0.6	0.09	1.2	0.18	1.9	0.29	2.6	0.40	3.4	0.52	4.2	0.64
24	0.124	−0.6	−0.09	0.6	0.10	1.3	0.20	2.1	0.32	2.8	0.43	3.7	0.57	4.6	0.71
26	0.137	−0.7	−0.10	0.7	0.11	1.4	0.22	2.3	0.35	3.1	0.48	4.1	0.63	5.1	0.78
28	0.150	−0.7	−0.11	0.8	0.12	1.6	0.24	2.5	0.38	3.4	0.52	4.5	0.69	5.6	0.86
30	0.165	−0.8	−0.12	0.8	0.13	1.7	0.27	2.7	0.42	3.8	0.58	4.9	0.75	6.1	0.92
32	0.180	−0.9	−0.13	0.9	0.14	1.9	0.29	3.0	0.45	4.1	0.63	5.3	0.82	6.6	1.01
34	0.197	−0.9	−0.14	1.0	0.15	2.1	0.32	3.2	0.49	4.4	0.68	5.7	0.88	7.2	1.11
36	0.212	−1.0	−0.15	1.1	0.17	2.2	0.35	3.5	0.53	4.8	0.74	6.2	0.96	7.8	1.20
38	0.229	−1.1	−0.17	1.2	0.18	2.4	0.37	3.8	0.58	5.2	0.80	6.8	1.05	8.4	1.30
40	0.248	−1.2	−0.18	1.3	0.20	2.6	0.41	4.1	0.63	5.7	0.88	7.4	1.14	9.2	1.42
42	0.268	−1.3	−0.20	1.4	0.21	2.8	0.44	4.4	0.69	6.1	0.94	[illegible]	1.23	10.0	1.54
44	0.289	−1.4	−0.22	1.5	0.23	3.1	0.47	4.8	0.74	6.7	1.04	8.7	1.34	10.8	1.67
46	0.312	−1.5	−0.23	1.6	0.25	3.3	0.51	5.2	0.80	7.2	1.11	9.4	1.45	11.7	1.81
48	0.336	−1.6	−0.25	1.8	0.27	3.6	0.56	5.6	0.87	7.8	1.21	[illegible]	1.58	12.6	1.95
49	0.3491	−1.7	−0.26	1.8	0.28	3.7	0.58	5.3	0.90	8.1	1.25	[illegible]	1.63	13.1	2.05
50	0.3624	−1.7	−0.27	1.9	0.29	3.9	0.60	6.1	0.94	8.4	1.30	10.7	1.69	13.6	2.11
51	0.3761	−1.8	−0.28	2.0	0.30	4.0	0.63	6.3	0.97	8.7	1.35	11.3	1.75	14.1	2.18
52	0.3903	−1.9	−0.29	2.0	0.32	4.2	0.65	6.5	1.01	9.0	1.40	11.8	1.83	14.7	2.28
53	0.4049	−1.9	−0.30	2.1	0.33	4.4	0.68	6.7	1.05	9.3	1.44	12.2	1.89	15.2	2.36
54	0.4200	−2.0	−0.31	2.2	0.34	4.5	0.70	7.0	1.09	9.7	1.50	12.7	1.97	15.8	2.45
55	0.4356	−2.1	−0.32	2.3	0.35	4.7	0.73	7.3	1.13	10.1	1.57	13.2	2.05	16.4	2.54
56	0.4518	−2.2	−0.34	2.4	0.37	4.9	0.76	7.6	1.18	10.5	1.63	13.7	2.13	17.1	2.66
57	0.4684	−2.3	−0.35	2.4	0.37	5.1	0.79	7.9	1.22	10.9	1.69	14.2	2.21	17.7	2.75
58	0.4856	−2.3	−0.37	2.5	0.39	5.3	0.82	8.2	1.27	11.3	1.76	14.7	2.28	18.4	2.86
59	0.5033	−2.4	−0.38	2.6	0.41	5.4	0.85	8.5	1.32	11.7	1.82	15.3	2.38	19.1	2.97
60	0.522	−2.5	−0.40	2.7	0.42	5.7	0.88	8.8	1.37	12.2	1.90	15.9	2.47	19.9	3.09
61	0.540	−2.6	−0.41	2.8	0.44	5.9	0.91	9.2	1.43	12.7	1.98	16.5	2.57	20.7	3.22
62	0.560	−2.7	−0.43	2.9	0.46	6.1	0.95	9.5	1.48	13.2	2.05	17.1	2.66	21.4	3.33
63	0.580	−2.8	−0.44	3.0	0.48	6.3	0.98	9.9	1.54	13.7	2.13	17.7	2.76	22.3	3.47
64	0.601	−2.9	−0.46	3.2	0.49	6.5	1.02	10.2	1.59	14.2	2.21	18.4	2.87	23.1	3.60
65	0.622	−3.1	−0.48	3.3	0.51	6.8	1.06	10.6	1.65	14.7	2.29	19.1	2.98	23.9	3.73
66	0.644	−3.2	−0.50	3.4	0.53	7.1	1.10	11.0	1.72	15.3	2.38	19.8	3.09	24.8	3.87
67	0.667	−3.3	−0.51	3.5	0.55	7.3	1.14	11.4	1.78	15.8	2.47	20.5	3.20	25.7	4.01
68	0.690	−3.4	−0.53	3.7	0.57	7.6	1.18	11.8	1.84	16.4	2.56	21.3	3.32	26.7	4.16
69	0.714	−3.5	−0.55	3.8	0.59	7.9	1.23	12.2	1.90	17.0	2.65	22.1	3.45	27.7	4.32
70	0.739	−3.7	−0.57	3.9	0.61	8.1	1.27	12.7	1.98	17.6	2.75	22.9	3.58	28.7	4.48
71	0.765	−3.8	−0.59	4.1	0.64	8.4	1.32	15.1	2.05	18.2	2.84	23.7	3.70	29.7	4.64
72	0.791	−3.9	−0.61	4.2	0.66	8.7	1.36	13.6	2.13	18.8	2.94	24.6	3.84	30.9	4.82
73	0.818	−4.1	−0.63	4.4	0.69	9.0	1.41	14.1	2.20	19.5	3.05	25.5	3.99	31.9	4.99
74	0.846	−4.2	−0.66	4.6	0.71	9.4	1.46	14.6	2.28	20.2	3.16	26.4	4.14	33.1	5.18
75	0.875	−4.4	−0.68	4.7	0.74	9.7	1.52	15.1	2.36	20.9	3.27	27.4	4.28	34.3	5.37
76	0.905	−4.5	−0.71	4.9	0.77	10.0	1.57	15.7	2.46	21.7	3.39	28.3	4.42	35.5	5.56
77	0.935	−4.7	−0.73	5.1	0.79	10.4	1.63	16.3	2.55	22.5	3.52	29.4	4.61	36.9	5.77
78	0.967	−4.9	−0.76	5.2	0.82	10.8	1.69	16.9	2.65	23.3	3.65	30.5	4.77	38.2	5.98
79	0.999	−5.0	−0.79	5.4	0.85	11.2	1.75	17.5	2.74	24.2	3.79	31.6	4.95	39.6	6.20
80	1.032	−5.2	−0.82	5.6	0.88	11.6	1.82	18.1	2.84	25.1	3.93	32.7	5.13	41.0	6.43
81	1.067	−5.4	−0.85	5.8	0.91	12.0	1.88	18.8	2.95	26.0	4.08	33.9	5.32	42.5	6.66
82	1.102	−5.6	−0.88	6.0	0.94	12.5	1.96	19.5	3.06	27.0	4.24	35.1	5.51	44.0	6.90
83	1.138	−5.8	−0.91	6.2	0.97	12.9	2.02	20.2	3.17	28.0	4.39	36.4	5.71	45.6	7.15
84	1.175	−6.0	−0.94	6.4	1.00	13.3	2.10	20.9	3.28	28.9	4.54	37.7	5.92	47.2	7.41
85	1.214	−6.2	−0.97	6.7	1.05	13.8	2.17	21.6	3.39	29.9	4.69	39.0	6.12	48.9	7.67
86	1.253	−6.4	−1.00	6.9	1.08	14.3	2.24	22.3	3.50	30.9	4.85	40.4	6.34	50.6	7.94
87	1.294	−6.7	−1.05	7.1	1.11	14.8	2.32	23.1	3.63	32.0	5.02	41.8	6.56	52.3	8.21
88	1.335	−6.9	−1.08	7.4	1.16	15.3	2.40	23.9	3.75	33.1	5.20	43.2	6.79	54.2	8.51
89	1.378	−7.1	−1.12	7.7	1.21	15.9	2.50	24.8	3.90	34.3	5.39	44.8	7.04	56.2	8.83

See Reference No. 10

CORRECTION TABLES FOR PSYCHROMETRIC CHART – ALTITUDE – (FAHRENHEIT)

(continued)

Additive Corrections for W, h, and v When Barometric Pressure Differs from Standard Barometer

Wet Bulb Temp. t'	Sat. Vapor Press. In. Hg	−900		900		1800		2700		3700		48[illegible]		5900	
		$\Delta p = +1$		$\Delta p = -1$		$\Delta p = -2$		$\Delta p = -3$		$\Delta p = -4$		$\Delta p = -5$		$\Delta p = -6$	
		$\Delta W_s'$	Δh	$\Delta W_s'$	Δh	$\Delta W_s'$	Δh	$\Delta W_s'$	Δh	$\Delta W_s'$	Δh	$\Delta W_s'$	Δh	$\Delta W_s'$	Δh
90	1.422	−7.4	−1.16	7.9	1.24	16.5	2.59	25.7	4.04	35.6	5.60	46.4	7.29	58.2	9.15
91	1.467	−7.6	−1.20	8.2	1.29	17.0	2.67	26.6	4.18	36.9	5.80	48.1	7.56	60.3	9.48
92	1.514	−7.9	−1.24	8.5	1.34	17.6	2.77	27.5	4.33	38.2	6.01	49.8	7.83	62.5	9.83
93	1.561	−8.2	−1.29	8.8	1.39	18.3	2.88	28.5	4.49	39.6	6.23	51.5	8.11	64.7	10.18
94	1.610	−8.5	−1.34	9.1	1.43	18.9	2.98	29.5	4.64	41.0	6.46	53.4	8.41	67.0	10.55
95	1.661	−8.8	−1.39	9.4	1.48	19.6	3.09	30.5	4.80	42.4	6.68	55.2	8.69	69.3	10.92
96	1.712	−9.1	−1.43	9.8	1.54	20.2	3.18	31.5	4.96	43.8	6.90	57.2	9.01	71.7	11.30
97	1.766	−9.4	−1.48	10.1	1.59	20.9	3.29	32.6	5.14	45.3	7.14	59.2	9.33	74.2	11.70
98	1.820	−9.7	−1.53	10.4	1.64	21.7	3.42	33.8	5.33	47.0	7.41	61.3	9.67	76.8	12.11
99	1.876	−10.1	−1.59	10.8	1.70	22.4	3.53	35.0	5.52	48.6	7.67	63.5	10.02	79.6	12.56
100	1.933	−10.4	−1.64	11.2	1.77	23.2	3.66	36.3	5.73	50.4	7.95	65.7	10.37	82.5	13.02
101	1.992	−10.8	−1.71	11.6	1.83	24.0	3.79	37.6	5.94	52.2	8.24	68.0	10.74	85.4	13.48
102	2.053	−11.1	−1.75	12.0	1.90	24.8	3.92	38.9	6.14	54.1	8.54	70.5	11.13	88.5	13.98
103	2.115	−11.5	−1.82	12.4	1.96	25.7	4.06	40.3	6.37	56.0	8.85	72.9	11.52	91.[illegible]	14.47
104	2.179	−11.9	−1.88	12.8	2.02	26.6	4.20	41.6	6.58	57.9	9.15	75.5	11.93	94.8	14.98
105	2.244	−12.4	−1.96	13.3	2.10	27.6	4.36	43.1	6.82	59.9	9.47	78.2	12.37	98.2	15.53
106	2.311	−12.8	−2.02	13.7	2.17	28.6	4.52	44.6	7.06	62.1	9.82	81.1	12.83	101.7	16.09
107	2.381	−13.2	−2.09	14.2	2.25	29.6	4.68	46.2	7.31	64.3	10.17	84.1	13.31	105.3	16.66
108	2.450	−13.7	−2.17	14.7	2.33	30.6	4.84	47.7	7.55	66.5	10.53	87.0	13.77	109.1	17.27
109	2.523	−14.2	−2.25	15.3	2.42	31.7	5.02	49.4	7.82	68.9	10.91	90.0	14.25	113.[illegible]	17.90
110	2.597	−14.7	−2.33	15.8	2.50	32.8	5.20	51.3	8.13	71.3	11.30	93.1	14.75	117.0	18.54
111	2.673	−15.2	−2.41	16.3	2.58	34.0	5.39	55.1	8.42	73.8	11.70	96.4	15.28	121.4	19.24
112	2.751	−15.7	−2.49	16.9	2.68	35.2	5.58	55.0	8.72	76.4	12.11	99.9	15.84	125.9	19.96
113	2.831	−16.3	−2.58	17.5	2.78	36.4	5.77	56.9	9.03	79.2	12.56	103.5	16.42	130.4	20.68
114	2.913	−16.9	−2.68	18.1	2.87	37.7	5.98	58.9	9.50	82.0	13.01	107.3	17.03	135.0	21.42
115	2.996	−17.4	−2.76	18.8	2.98	39.1	6.21	61.0	9.68	85.0	13.49	111.1	17.64	139.7	22.18
116	3.082	−18.0	−2.86	19.4	3.08	40.4	6.42	63.2	10.03	88.0	13.97	115.1	18.28	144.7	22.98
117	3.170	−18.7	−2.97	20.1	3.19	41.8	6.64	65.4	10.38	91.2	14.49	119.2	18.94	150.0	23.83
118	3.260	−19.3	−3.07	20.8	3.31	43.3	6.88	67.8	10.77	94.4	15.00	123.5	19.63	155.4	24.73
119	3.353	−20.0	−3.18	21.6	3.43	44.9	7.14	70.3	11.18	97.9	15.56	128.0	20.35	161.1	25.61
120	3.448	−20.7	−3.29	22.4	3.56	46.6	7.41	72.8	11.58	101.4	16.13	132.7	21.10	167.1	26.58
121	3.545	−21.4	−3.40	23.2	3.77	48.3	7.68	75.5	12.01	105.1	16.72	137.6	21.89	173.2	27.56
122	3.644	−22.2	−3.53	24.0	3.82	50.0	7.96	78.2	12.45	109.0	17.35	142.6	22.70	179.6	28.58
123	3.746	−23.0	−3.66	24.9	3.96	51.8	8.25	81.1	12.91	112.9	17.98	147.9	23.55	186.3	29.66
124	3.850	−23.8	−3.79	25.8	4.11	53.7	8.55	84.0	13.38	117.1	18.65	153.3	24.42	193.2	30.77
125	3.956	−24.7	−3.94	26.7	4.25	55.6	8.86	87.1	13.88	121.4	19.34	159.1	25.35	200.5	31.95
126	4.065	−25.6	−4.08	27.6	4.40	57.7	9.20	90.3	14.39	125.9	20.07	165.0	26.30	208.0	33.15
127	4.177	−26.5	−4.23	28.6	4.56	59.8	9.54	93.6	14.93	130.6	20.83	171.2	27.30	215.8	34.41
128	4.291	−27.5	−4.39	29.7	4.74	62.0	9.89	97.1	15.49	135.5	21.61	177.6	28.33	224.0	35.73
129	4.408	−28.5	−4.55	30.8	4.92	64.3	10.26	100.7	16.07	140.6	22.44	184.3	29.41	232.6	37.12
130	4.527	−29.5	−4.71	32.0	5.11	66.7	10.64	104.5	16.68	145.9	23.29	191.4	30.55	241.5	38.35
131	4.650	−30.6	−4.89	33.2	5.30	69.2	11.05	108.5	17.33	151.4	24.18	198.7	31.73	250.3	40.05
132	4.775	−31.8	−5.08	34.4	5.50	71.8	11.47	112.6	17.99	157.2	25.11	206.3	32.96	260.6	41.63
133	4.903	−32.9	−5.26	35.8	5.72	74.5	11.91	116.9	18.68	163.3	26.10	214.3	34.25	270.8	43.28
134	5.034	−34.2	−5.47	37.1	5.93	77.4	12.37	121.4	19.41	169.6	27.12	222.7	35.60	281.4	44.98
135	5.168	−35.5	−5.68	38.5	6.16	80.3	12.84	126.0	20.15	176.2	28.18	231.4	37.01	292.6	46.80
136	5.305	−36.8	−5.89	40.0	6.40	83.4	13.34	130.9	20.94	183.1	29.30	240.5	38.48	304.2	48.67
137	5.445	−38.2	−6.11	41.5	6.64	86.6	13.86	136.0	21.77	190.3	30.46	250.1	40.03	316.4	50.64
138	5.588	−39.7	−6.36	43.2	6.92	90.0	14.41	141.4	22.64	197.8	31.67	260.1	41.65	329.3	52.73
139	5.735	−41.2	−6.60	44.8	7.18	93.6	14.99	147.0	23.55	205.7	32.95	270.6	43.34	342.7	54.89
140	5.884	−42.8	−6.86	46.5	8.45	97.3	15.59	152.8	24.48	214.0	34.29	281.6	45.12	356.8	57.17

t = Dry bulb temperature (°F).
t' = Wet bulb temperature (°F).
p = Barometric pressure (in. of Hg).
Δp = Pressure difference from standard barometer (in. of Hg).
W = Moisture content of air (gr. per lb. of dry air).
W_s' = Moisture content of air saturated at wet bulb temperature t' (gr. per lb. of dry air).
ΔW = Moisture content correction of air when barometric pressure differs from standard barometer (gr. per lb. of dry air).
$\Delta W_s'$ = Moisture content correction of air saturated at wet bulb temperature when barometric pressure differs from standard barometer (gr. per lb of dry air).
NOTE: To obtain ΔW reduce value of $\Delta W_s'$ by 1% where $t - t' = 24°F$ and correct proportionally when $t - t'$ is not 24°F.
h = Enthalpy of moist air (B.t.u. per lb. of dry air).
Δh = Enthalpy correction when barometer pressure differs from standard barometer, for saturated or unsaturated air. (B.t.u. per lb. of dry air).
v = Volume of moist air (cu. ft. per lb. of dry air).

$$= \frac{.754\,(t + 459.8)}{p}\left[1 + \frac{W}{4360}\right]$$

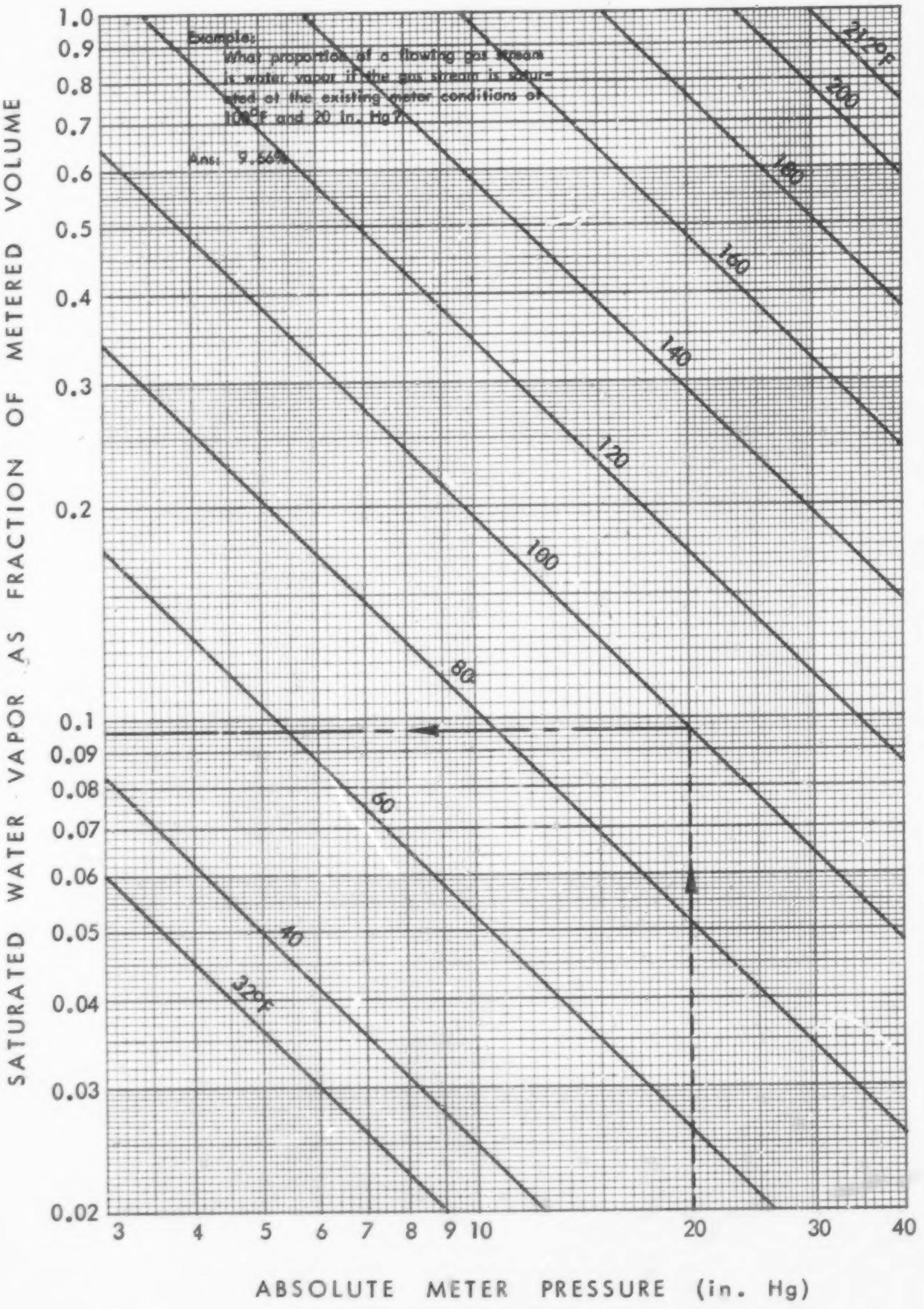
Example: At a barometric pressure of 25.92 with 220°F DB and 100°F WB, determine W, h, and $v\Delta$. $p = -4$ and from table $\Delta W_s' = 50.4$. From note above,

$$\Delta W = \Delta W_s' - \left(\frac{120}{24} \times .01 \times 50.4\right) = 50.4 - 2.5 = 47.9$$

Therefore W = 102 (from chart) + 47.9 = 149.9 gr. per lb of dry air. From table Δh = 7.95. Therefore h = saturation enthalpy from chart + deviation + 7.95 = 71.7 − 2.0 + 7.95 = 77.65 B.t.u. per lb. of dry air. From equation above

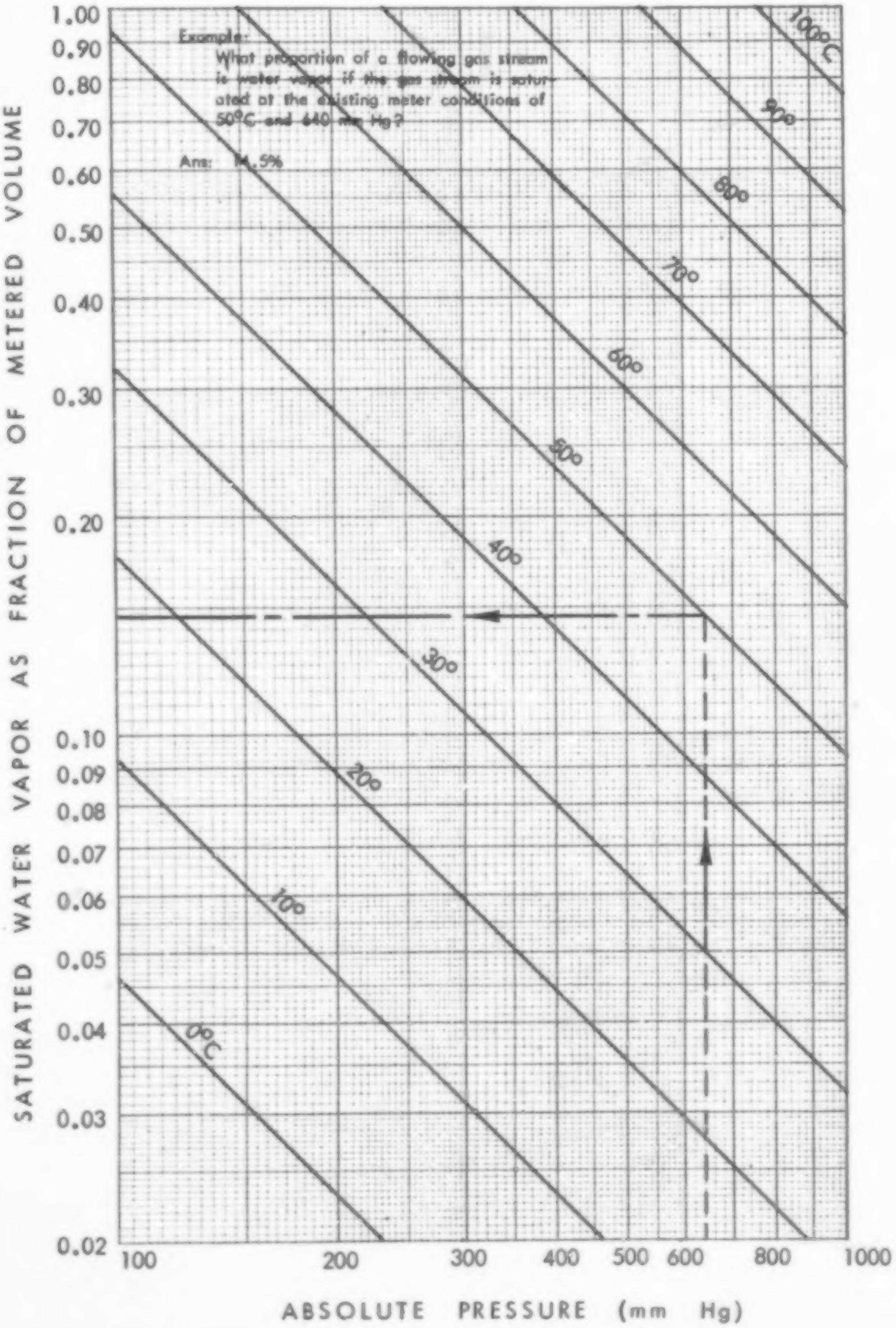
$$v = \frac{.754\,(220 + 459.7)}{25.92}\left[1 + \frac{149.9}{4360}\right] = 20.43 \text{ cu. ft. per lb. of dry air}$$

SATURATED WATER VAPOR AS FRACTION OF METERED VOLUME AS A FUNCTION OF ABSOLUTE PRESSURE (in. Hg.) AND TEMPERATURE (°F)


Example:
What proportion of a flowing gas stream is water vapor if the gas stream is saturated at the existing meter conditions of 100°F and 20 in. Hg?

Ans: 9.56%

SATURATED WATER VAPOR AS FRACTION OF METERED VOLUME AS A FUNCTION OF ABSOLUTE PRESSURE IN mm Hg, AND TEMPERATURE (°C)



Example:
What proportion of a flowing gas stream is water vapor if the gas stream is saturated at the existing meter conditions of 50°C and 640 mm Hg?

Ans: 14.5%

PSYCHROMETRIC NOMOGRAPHS FOR HIGH AND LOW PRESSURES

Example 1 (Centigrade Chart - Low Range)

Suppose a psychrometer reads 20°C on the dry bulb and 8°C on the wet bulb when the total (barometric) pressure is 60 cm Hg. To find the pressure of water vapor, place a straightedge so that it intersects the "Observed Dry Bulb Minus Wet Bulb,°C" scale at 20 - 8 = 12. Adjust it so that it intersects the "Barometer, cm Hg" scale at 60, and note the intersection with the "Sea Level Equivalent Dry Bulb Minus Wet Bulb,°C" scale (9.5). Holding the straightedge at this point, swing it so that it intersects the (central, nearly vertical) "Wet Bulb, °C" scale at 8, and read the pressure of water vapor (3.30) on the "Humidity, mm Hg" scale at the right. A computation from the psychrometric formula gives 3.312 mm Hg for this value.

Example 2 (Centigrade Chart - Low Range)

Continuing the example started above, hold the straightedge fixed at the value 3.30 on the "Humidity, mm Hg", and swing it so that it intersects the (diagonal) "Dry Bulb,°C" scale at 20. By extending this line to the vertical "Relative Humidity, Percent" scale (inner left), the relative humidity is found (18.8%). Computation gives 18.87% for the psychrometric data given originally.

Example 3 (Centigrade Chart - Low Range)

Continuing with the data of example 1, connect 3.30 on the "Humidity, mm Hg" scale by straightedge with 100 on the "Relative Humidity, Percent" scale. The intersection of the straightedge with the "Wet Bulb,°C" scale (-4.35°C) gives the dewpoint in terms of subcooled water; that with the "Ice Bulb, °C" scale(-3.85°C) gives the dewpoint relative to ice. Computed values are -4.37°C and -3.85°C.

Example 4 (Centigrade Chart - Low Range)

A psychrometer reads 20°C on the dry bulb and 8°C on the wet bulb when the barometer reads 74.35 cm Hg. The humidity can be obtained approximately by neglecting the the pressure correction, and using the observed wet-bulb depression as the sea-level equivalent depression. Place a straightedge on the "Sea Level Equivalent Dry Bulb Minus Wet Bulb,°C" scale at 20 - 8 = 12, and adjust so it intersects the "Wet Bulb,°C" scale at 8. The approximate humidity is read on the "Humidity, mm Hg" scale as 2.05 mm Hg. Computation gives the value 2.050 for a 76 cm Hg pressure (as is assumed in this approximate method) and 2.180 for the actual pressure of 74.35 cm Hg.

Example 5 (Centigrade Chart - Low Range)

When the dry-bulb temperature is 20°C and the relative humidity is 40%, what is the pressure of water vapor? Place a straightedge so that it connects 40 on the "Relative Humidity, Percent" scale with 20 on the (diagonal) "Dry Bulb,°C" scale, and read the pressure of water vapor (7.02 mm Hg) on the "Humidity, mm Hg" scale. Computation gives 7.019 mm Hg.

Example 6 (Centigrade Chart - Low Range)

It is desired to bring the atmosphere for which psychrometric data are given in example 1 to 50% relative humidity. To determine what dry-bulb temperature will accomplish this, connect 3.30 on the "Humidity, mm Hg" scale with 50 on the "Relative Humidity, Percent" scale. The required dry-bulb temperature, indicated by the intersection of the straightedge with the "Dry Bulb,°C" scale, is 5.2°C. By computation the value 5.20°C is obtained.

See Reference No. 21

Example 7 (Centigrade Chart - Low Range)

A psychrometer reads 24°C on the dry bulb and 8°C on the wet bulb when the pressure is 57 cm Hg. Using these values, the pressure of water vapor is found to be 2.05 mm Hg. By assuming separately the values 25°C on the dry bulb, 9°C on the wet bulb, and 58 cm Hg, the following sequence of values is found.

Dry, °C	Wet, °C	Pressure, cm Hg	Humidity, mm Hg	
			Chart	Formula
24	8	57	2.05	2.050
25	8	57	1.66	1.676
24	9	57	2.96	2.984
24	8	58	1.93	1.945

From these values, the effect of an error of one unit in each reading, and its reciprocal function, the precision requisite to obtaining a final value of desired precision, are obtained, as given below.

Unit error in	Error in final value, mm Hg	Precision for 1% relative humidity precision in result	Precision for 0.1 mm Hg precision in result
Dry bulb	0.39	0.58°C	0.26°C
Wet bulb	0.91	0.22°C	0.10°C
Pressure	0.12	1.86 cm Hg	0.83 cm Hg

PSYCHROMETRIC NOMOGRAPHS FOR HIGH AND LOW PRESSURES
(continued)

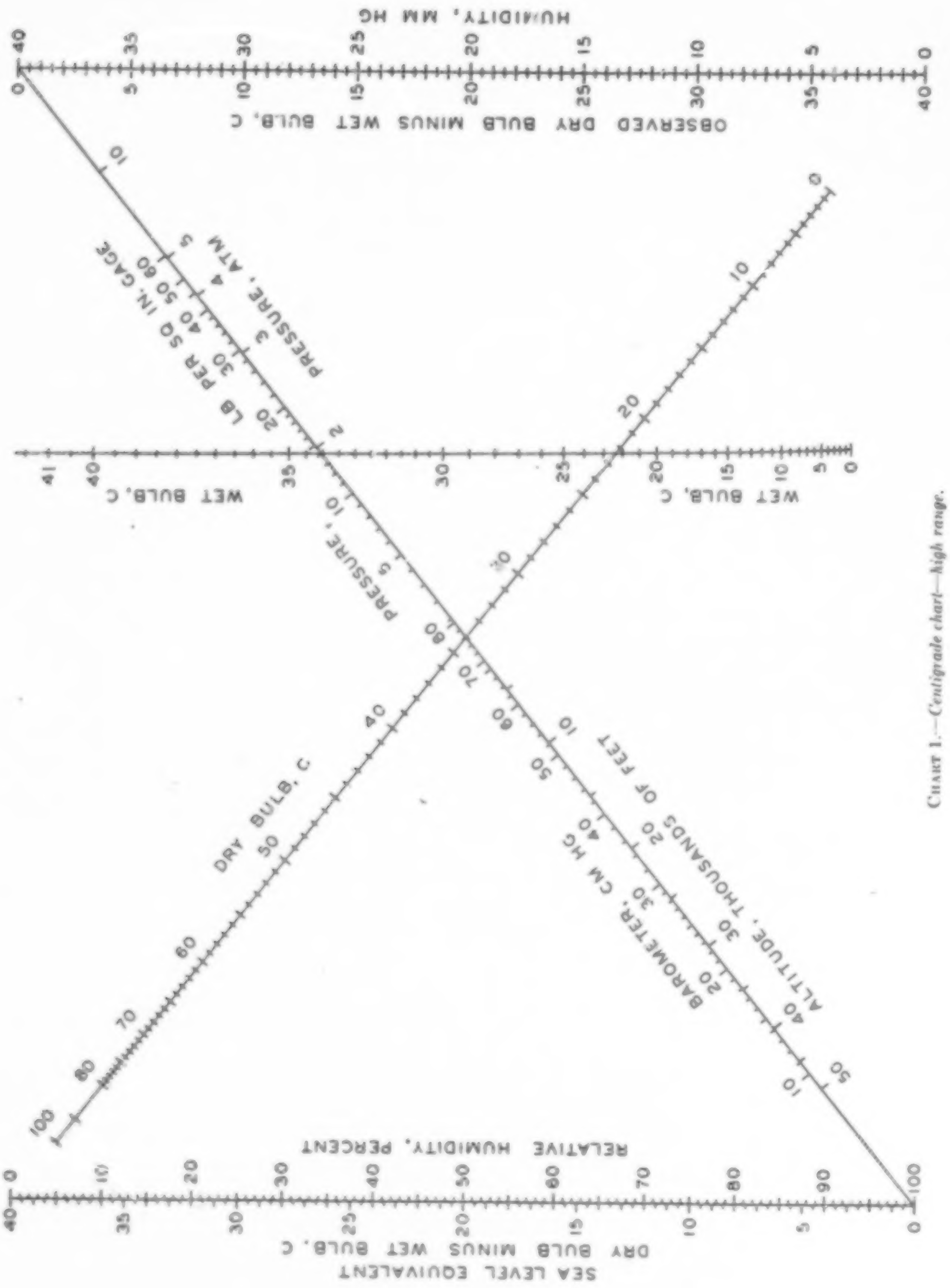


Chart 1.—Centigrade chart—high range.

PSYCHROMETRIC NOMOGRAPHS FOR HIGH AND LOW PRESSURES
(continued)

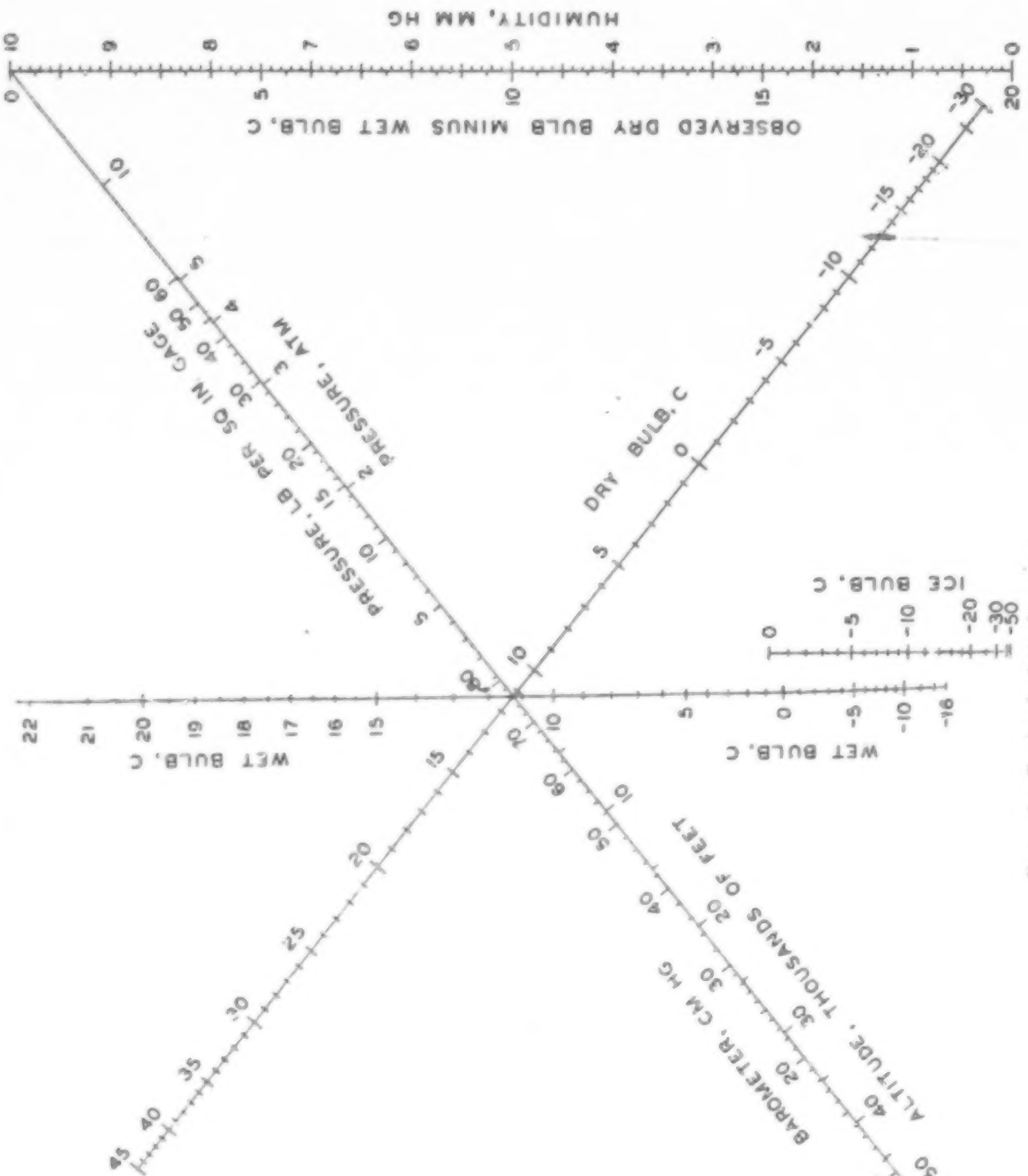

HUMIDITY, MM HG
OBSERVED DRY BULB MINUS WET BULB, C
DRY BULB, C
PRESSURE, ATM
PRESSURE, LB PER SQ IN GAGE
ICE BULB, C
WET BULB, C
WET BULB, C
ALTITUDE, THOUSANDS OF FEET
BAROMETER, CM HG
RELATIVE HUMIDITY, PERCENT
SEA LEVEL EQUIVALENT
DRY BULB MINUS WET BULB, C

CHART 2.—*Centigrade chart—low range.*

PSYCHROMETRIC NOMOGRAPHS FOR HIGH AND LOW PRESSURES
(continued)

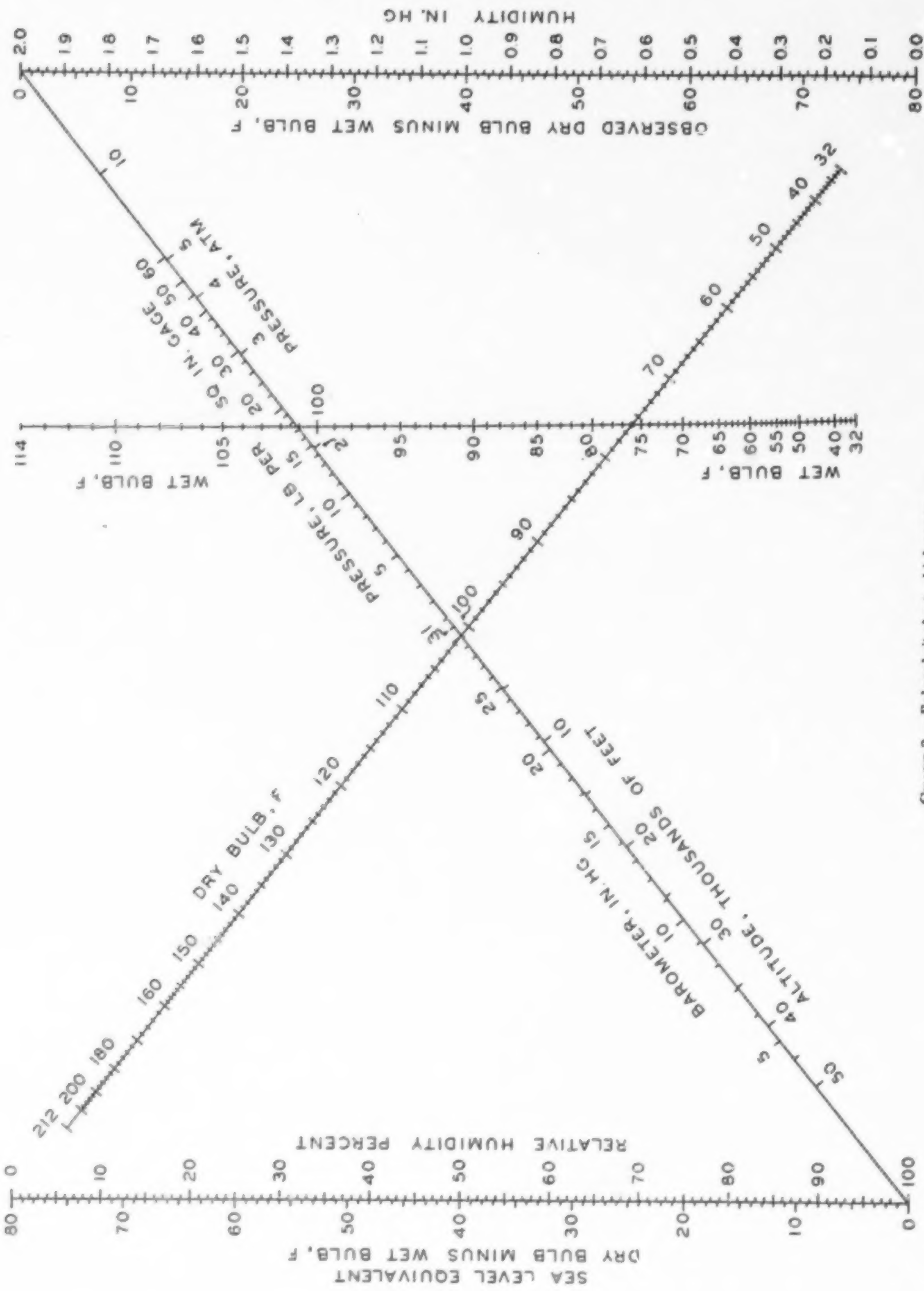


CHART 3.—*Fahrenheit chart—high range.*

PSYCHROMETRIC NOMOGRAPHS FOR HIGH AND LOW PRESSURES
(continued)

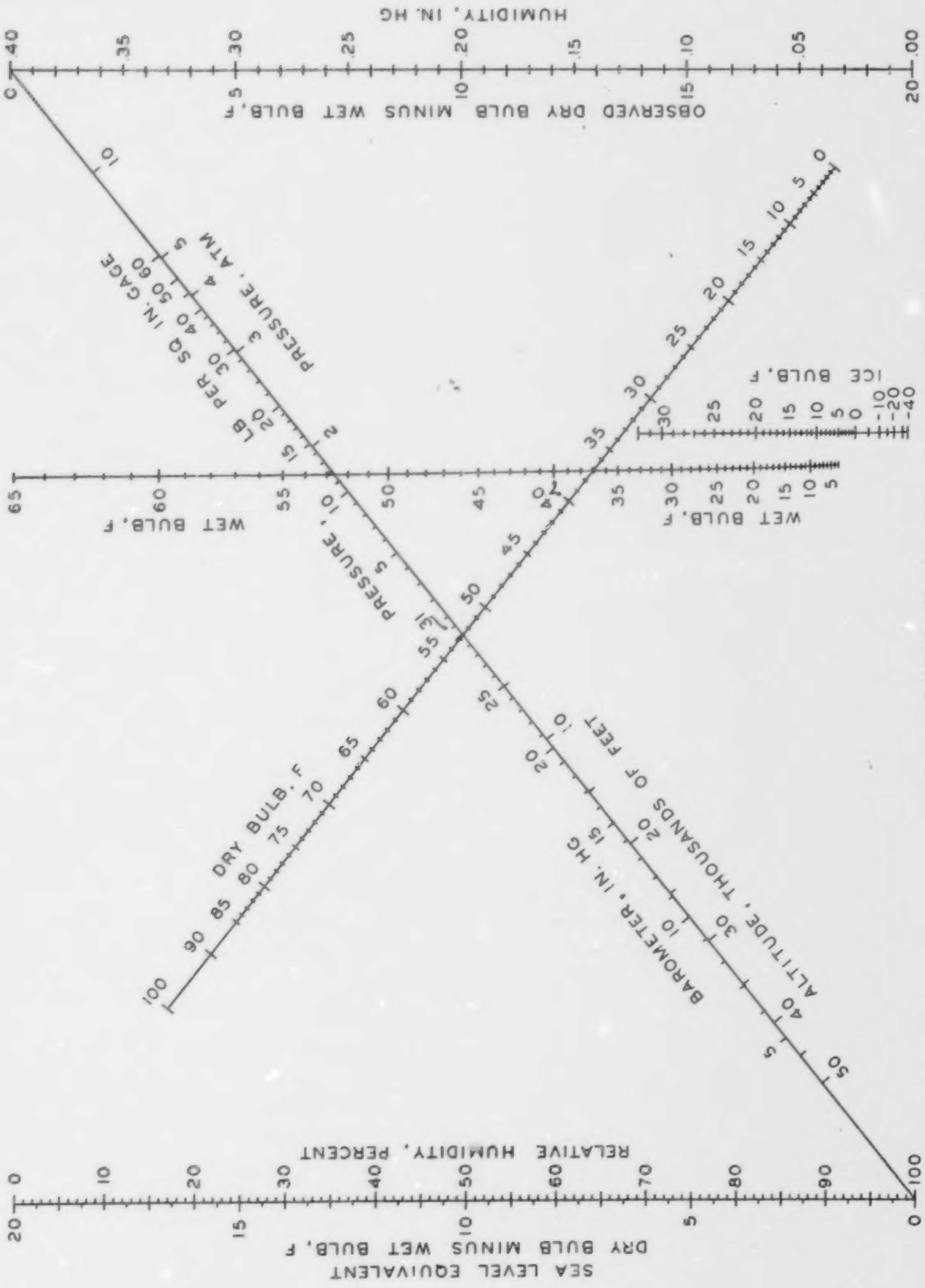
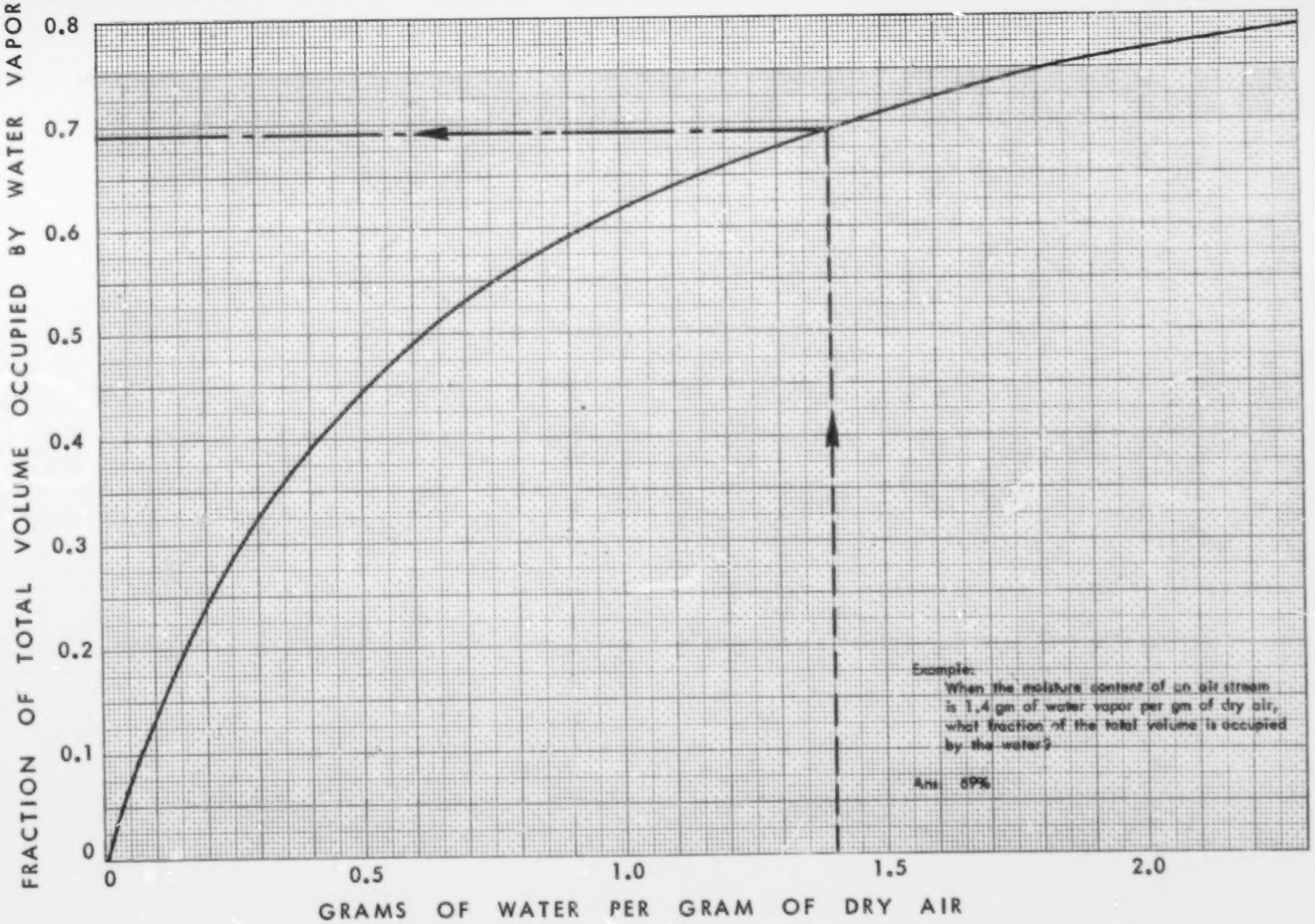


CHART 4.—*Fahrenheit chart—low range.*

FRACTION OF TOTAL VOLUME OCCUPIED BY WATER VAPOR VS. GMS. OF WATER PER GRAM OF DRY AIR.

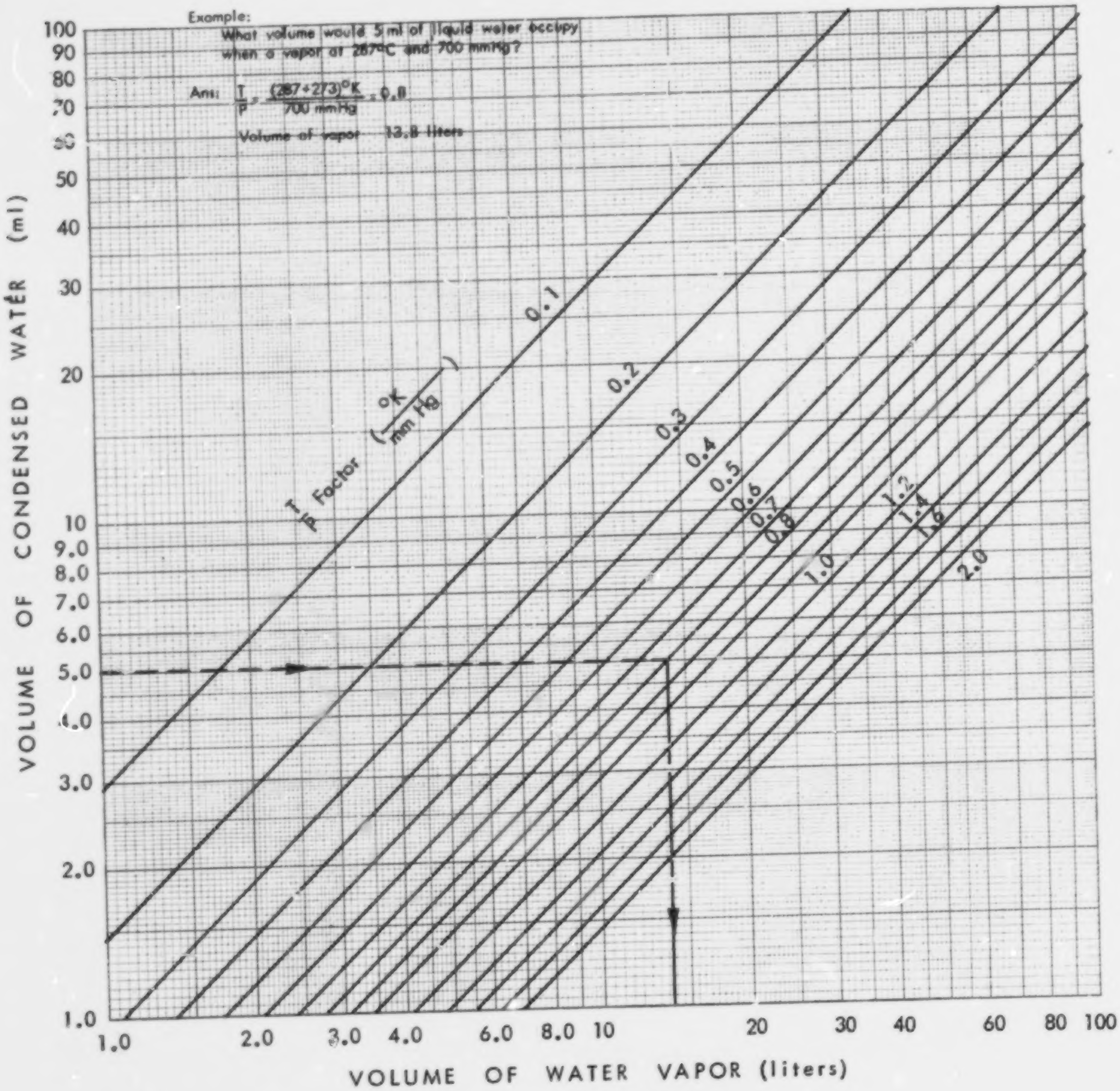


Example:

When the moisture content of an air stream is 1.4 gm of water vapor per gm of dry air, what fraction of the total volume is occupied by the water?

Ans 69%

GRAPHICAL METHOD FOR CONVERTING VOLUME OF CONDENSED WATER TO VOLUME OF WATER VAPOR AT CONDITIONS OF TEMPERATURE IN °K AND PRESSURE IN mm. Hg.



Example:

What volume would 5 ml of liquid water occupy when a vapor at 287°C and 700 mmHg?

Ans: $\frac{T}{P} = \frac{(287+273)^{\circ}K}{700\ mmHg} = 0.8$

Volume of vapor 13.8 liters

RELATIVE HUMIDITY TABLES

FAHRENHEIT TEMPERATURES, BAROMETRIC PRESSURE 30 in. Hg.

DIFFERENCE IN DEGREES FAHRENHEIT BETWEEN WET AND DRY BULB THERMOMETERS

DRY BULB Thermometer Readings	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
100	96	93	89	86	83	80	77	73	70	68	65	63	59	56	54	51	49	46	44	41
98	96	93	89	86	83	79	76	73	70	67	64	61	59	56	53	50	48	45	43	40
96	96	93	89	86	82	79	76	73	69	66	63	61	58	55	52	50	47	44	42	39
94	96	93	89	85	82	79	75	72	69	66	63	60	57	54	51	49	46	43	41	38
92	96	92	89	85	82	78	75	72	68	65	62	59	56	53	50	48	45	42	40	37
90	96	92	89	85	81	78	74	71	68	65	61	58	55	52	49	47	44	41	39	36
88	96	92	88	85	81	77	74	70	67	64	61	57	54	51	48	46	43	40	37	35
86	96	92	88	84	81	77	73	70	66	63	60	57	53	50	47	44	42	39	36	33
84	96	92	88	84	80	76	73	69	66	62	59	56	52	49	46	43	40	37	35	32
82	96	92	88	84	80	76	72	69	65	61	58	55	51	48	45	42	39	36	33	30
80	96	91	87	83	79	75	72	68	64	61	57	54	50	47	44	41	38	35	32	29
79	96	91	87	83	79	75	71	68	64	60	57	53	50	46	43	40	37	34	31	28
78	96	91	87	83	79	75	71	67	63	60	56	53	49	46	43	39	36	33	30	27
77	96	91	87	83	79	74	71	67	63	59	56	52	48	45	42	39	35	32	29	26
76	96	91	87	83	78	74	70	66	62	59	55	51	48	44	41	38	34	31	28	25
75	96	91	86	82	78	74	70	66	62	58	54	51	47	44	40	37	34	30	27	24
74	95	91	86	82	78	74	69	65	61	58	54	50	47	43	39	36	33	29	26	23
73	95	91	86	82	78	73	69	65	61	57	53	50	46	42	39	35	32	29	25	22
72	95	91	86	82	77	73	69	65	61	57	53	49	45	42	38	34	31	28	24	21
71	95	90	86	81	77	72	68	64	60	56	52	48	45	41	37	33	30	27	23	20
70	95	90	86	81	77	72	68	64	59	55	51	48	44	40	36	33	29	25	22	19
69	95	90	85	81	76	72	67	63	59	55	51	47	43	39	35	32	28	24	21	18
68	95	90	85	80	76	71	67	62	58	54	50	46	42	38	34	31	27	23	20	16
67	95	90	85	80	75	71	66	62	58	53	49	45	41	37	33	30	26	22	19	15
66	95	90	85	80	75	71	66	61	57	53	48	44	40	36	32	29	25	21	17	14
65	95	90	85	80	75	70	66	61	56	52	48	44	39	35	31	27	24	20	16	12
64	95	90	84	79	74	70	65	60	56	51	47	43	38	34	30	26	22	18	15	11
63	95	89	84	79	74	69	64	60	55	50	46	42	37	33	29	25	21	17	13	10
62	94	89	84	79	74	69	64	59	54	50	45	41	36	32	28	24	20	16	12	8
61	94	89	84	78	73	68	63	58	54	49	44	40	35	31	27	22	18	14	10	7
60	94	89	83	78	73	68	63	58	53	48	43	39	34	30	26	21	17	13	9	5
59	94	89	83	78	72	67	62	57	52	47	42	38	33	29	24	20	16	11	7	3
58	94	88	83	77	72	66	61	56	51	46	41	37	32	27	23	18	14	10	6	1
57	94	88	82	77	71	66	61	55	50	45	40	35	31	26	22	17	13	8	4	
56	94	88	82	76	71	65	60	55	50	44	39	34	30	25	20	16	11	7	2	
55	94	88	82	76	70	65	59	54	49	43	38	33	28	23	19	14	9	5	0	
54	94	88	82	76	70	64	59	53	48	42	37	32	27	22	17	12	8	3		
53	94	87	81	75	69	63	58	52	47	41	36	31	26	20	16	10	6	1		
52	94	87	81	75	69	63	57	51	46	40	35	29	24	19	14	9	4			
51	94	87	81	75	68	62	56	50	45	39	34	28	23	17	12	7	2			
50	93	87	80	74	67	61	55	49	43	38	32	27	21	16	10	5	0			
49	93	86	80	73	67	61	54	48	42	36	31	25	19	14	9	3				
48	93	86	79	73	66	60	54	47	41	35	29	23	18	12	7	1				
47	93	86	79	72	66	59	53	46	40	34	28	22	16	10	5					
46	93	86	79	72	65	58	52	45	39	32	26	20	14	8	2					
45	93	86	78	71	64	57	51	44	38	31	25	18	12	6						
44	93	85	78	71	63	56	49	43	36	30	23	16	10	4						
43	92	85	77	70	63	55	48	42	35	28	21	14	8	1						
42	92	85	77	69	62	55	47	40	33	26	19	12	5							
41	92	84	76	69	61	54	46	39	31	24	17	10	3							
40	92	83	75	68	60	52	45	37	29	22	15	7	0							
39	92	83	75	67	59	51	43	35	27	20	12	5								
38	91	83	75	66	58	50	42	33	25	17	10	2								
37	91	83	74	65	57	48	40	31	23	15	7									
36	91	82	73	64	55	46	38	29	21	13	5									
35	91	81	72	63	54	45	36	27	19	10	2									
34	90	81	71	62	52	43	34	25	16	8										
33	90	80	70	60	51	41	32	23	14	5										
32	89	79	69	59	49	39	30	20	11	2										
31	89	78	68	58	47	37	28	18	8											
30	89	78	67	56	46	36	26	16	6											
29	88	77	66	55	44	34	23	13	3											
28	88	76	65	54	43	32	21	10												
27	88	76	64	52	41	29	18	7												
26	87	75	63	51	39	27	16	4												
25	87	74	62	49	37	25	13	1												
24	87	73	60	47	35	22	10													
23	86	72	59	46	33	20	7													
22	86	71	58	44	31	17	4													
21	85	71	56	42	28	15	1													
20	85	70	55	40	26	12														

DRY BULB Thermometer Readings	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
200	98	96	94	92	90	88	86	84	82	80	79	77	75	74	72	70	69	67	66	64	63	61	60	58	57	55	54	53	52	51
190	98	96	94	92	90	88	86	84	82	80	78	76	75	73	71	69	68	66	65	63	62	60	58	57	56	54	53	51	50	49
188	98	96	94	92	90	87	85	84	82	80	78	76	74	73	71	69	68	66	64	63	62	59	58	57	55	54	52	51	50	49
186	98	96	94	92	90	87	85	83	82	80	78	76	74	72	71	69	67	66	64	62	61	59	58	56	55	53	52	51	49	48
184	98	96	94	92	89	87	85	83	82	79	77	76	74	72	70	69	67	65	64	62	61	59	57	56	55	53	52	50	49	48
182	98	96	94	91	89	87	85	83	81	79	77	75	74	72	70	68	67	65	63	62	60	59	57	56	54	53	51	50	49	48
180	98	96	94	91	89	87	85	83	81	79	77	75	73	72	70	68	67	65	63	62	60	58	57	55	54	52	51	50	48	47
178	98	96	94	91	89	87	85	83	81	79	77	75	73	72	70	68	66	64	63	61	60	58	56	55	54	52	51	49	48	47
176	98	96	94	91	89	87	85	83	81	79	77	75	73	71	70	68	66	64	63	61	60	58	56	55	53	52	50	49	48	46
174	98	95	93	91	89	87	84	83	81	78	76	75	73	71	69	67	66	64	62	61	59	57	56	54	52	51	50	49	47	46
172	98	95	93	91	89	86	84	82	81	78	76	74	73	71	69	67	66	64	62	60	59	57	55	54	53	51	50	48	47	46
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160	98	95	93	90	88	86	83	81	79	77	75	73	71	69	67	65	64	62	60	58	57	55	53	52	50	49	47	46	44	43
158	98	95	93	90	88	86	83	81	79	77	75	73	71	69	67	65	63	61	60	58	56	55	53	51	50	48	47	45	44	43
156	98	95	93	90	88	85	83	81	79	77	74	72	71	69	67	65	63	61	59	58	56	54	53	51	49	48	46	45	43	42
154	98	95	93	90	88	85	83	81	79	77	74	72	70	68	66	65	63	61	59	57	56	54	52	50	49	47	46	44	43	42
152	98	95	93	90	88	85	83	81	79	76	74	72	70	68	66	64	62	60	59	57	55	53	52	50	48	47	46	44	42	41
150	98	95	92	90	87	85	82	80	78	76	74	72	70	68	66	64	62	60	58	57	55	53	51	49	48	46	45	43	42	41
148	97	95	92	90	87	85	82	80	78	76	73	71	69	67	65	63	61	60	58	56	54	53	51	49	48	46	45	43	42	40
146	97	95	92	90	87	85	82	80	78	75	73	71	69	67	65	63	61	58	57	56	54	52	50	49	47	45	44	43	41	40
144	97	95	92	89	87	84	82	80	78	75	73	71	69	67	65	63	61	59	57	55	53	52	50	48	47	45	44	42	41	39
142	97	94	92	89	87	84	82	80	77	75	73	70	68	66	64	62	60	58	57	55	53	51	49	48	46	44	43	42	40	39
140	97	94	92	89	87	84	82	79	77	75	73	70	68	66	63	62	60	58	56	54	53	51	49	47	46	44	43	41	40	38
138	97	94	92	89	87	84	82	79	77	75	72	70	68	66	64	62	60	58	56	54	52	50	49	47	45	44	42	40	39	37
136	97	94	92	89	86	84	81	79	77	74	72	70	68	65	63	61	59	57	55	54	52	50	48	46	45	43	41	40	38	37
134	97	94	92	89	86	84	81	79	76	74	72	69	67	65	63	61	59	57	55	53	51	49	48	46	44	43	41	39	38	36
132	97	94	92	89	86	84	81	79	76	74	71	69	67	65	63	61	58	56	55	53	51	49	47	45	44	42	40	39	37	36
130	97	94	91	89	86	83	81	78	76	73	71	69	67	64	62	60	58	56	54	52	50	48	47	45	43	41	40	38	37	35
128	97	94	91	89	86	83	81	78	76	73	71	68	66	64	62	60	58	56	54	52	50	48	46	44	42	41	39	37	36	34
126	97	94	91	88	86	83	80	78	75	73	70	68	66	64	61	59	57	55	53	51	49	47	45	44	42	40	38	37	35	33
124	97	94	91	88	85	83	80	78	75	73	70	68	65	63	61	59	57	54	52	50	48	47	45	43	41	39	38	36	34	33
122	97	94	91	88	85	83	80	77	75	73	70	67	65	63	60	58	56	54	52	50	48	46	44	42	40	39	37	35	34	32
120	97	94	91	88	85	82	80	77	74	72	69	67	65	62	60	58	55	53	51	49	47	45	43	41	40	38	36	34	33	31
118	97	94	91	88	85	82	79	77	74	72	69	67	64	62	59	57	55	53	51	49	47	45	43	41	39	37	35	34	32	30
116	97	94	91	88	85	82	79	76	74	71	69	66	64	61	59	57	54	52	50	48	46	44	42	40	38	36	34	33	31	29
114	97	94	91	88	85	82	79	76	74	71	68	66	63	61	58	56	54	52	49	47	45	43	41	39	37	35	34	32	30	28
112	97	94	90	87	84	81	79	76	73	70	68	65	63	60	58	55	53	51	49	47	44	42	40	38	36	35	33	31	29	27
110	97	93	90	87	84	81	78	75	73	70	67	65	62	60	57	55	52	50	48	46	44	42	40	38	36	34	32	30	28	26
108	97	93	90	87	84	81	78	75	72	70	67	64	62	59	57	54	52	49	47	45	43	41	39	37	35	33	31	29	27	25
106	97	93	90	87	84	81	78	75	72	69	66	64	61	58	56	53	51	49	46	44	42	40	38	36	34	32	30	28	26	24
104	97	93	90	87	83	80	77	74	71	69	66	63	60	58	55	53	50	48	46	43	41	39	37	35	33	31	29	27	25	23
102	96	93	90	86	83	80	77	74	71	68	65	62	60	57	55	52	49	47	45	42	40	38	36	34	32	30	28	26	24	22
100	96	93	89	86	83	80	77	73	70	68	65	62	59	56	54	51	49	46	44	41	39	37	35	33	30	28	26	24	22	21

To determine relative humidity from wet and dry bulb temperatures subtract wet bulb temperature from dry bulb temperature, find number at top representing this difference then follow down column vertically to intersection of horizontal column representing dry bulb temperature.

Formula for transposing temperature values:

$$F^\circ = \frac{C^\circ \times 9}{5} + 32 \qquad C^\circ = \frac{F^\circ - 32 \times 5}{9}$$

See Reference No. 16

SECTION 12 PROPERTIES OF GASES

Graphical Solution of Boyle's Law, $P_1V_1 = P_2V_2 = C$ for P in mm.Hg and V in Liters 12-1
Graphical Solution of Charles Law, $P_1/T_1 = P_2/T_2 = C$ for P in mm.Hg and T in °K 12-2
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Viscosities of Gases at One Atmosphere 12-11
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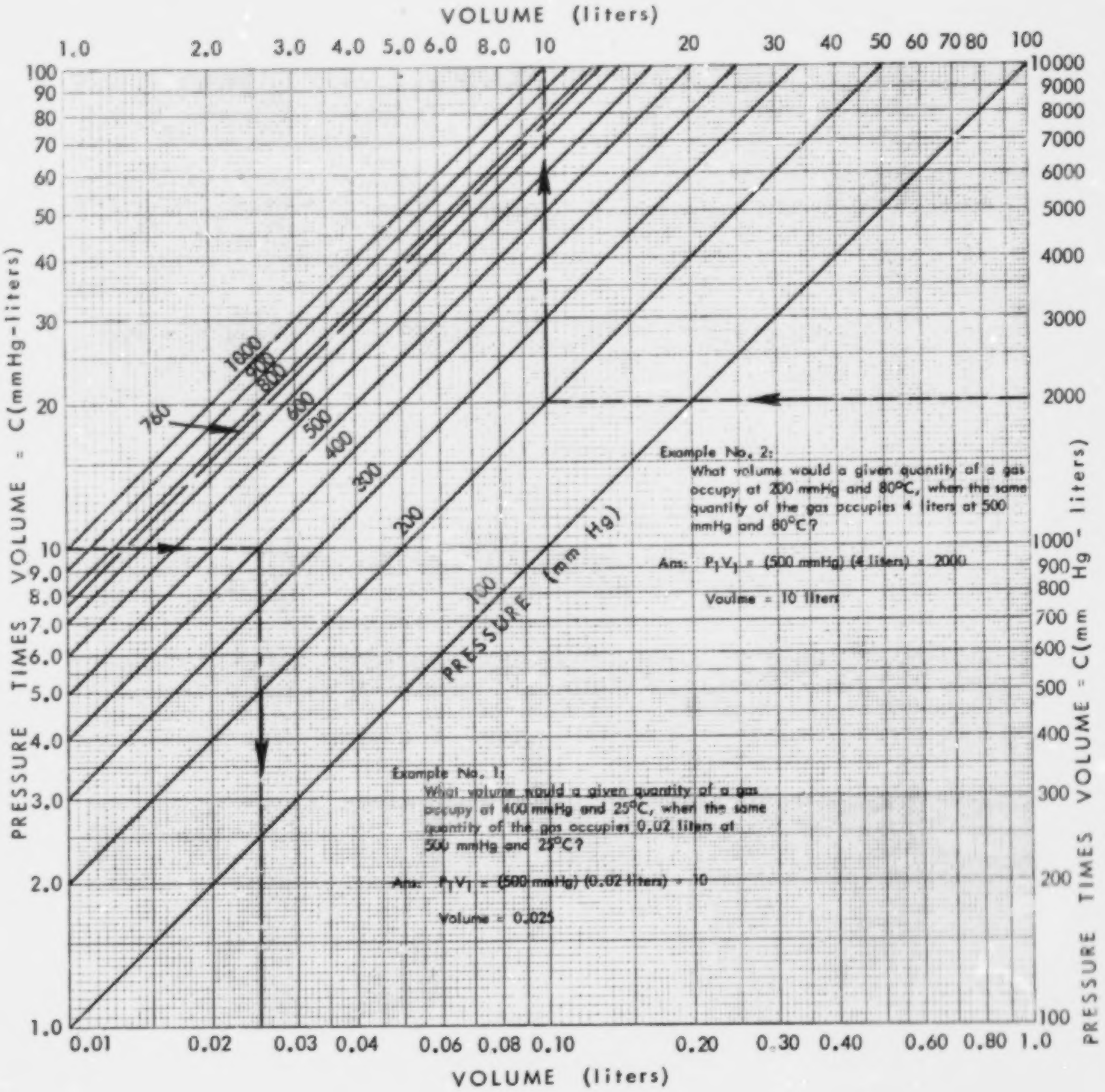
GRAPHICAL SOLUTION OF BOYLES LAW.
$P_1V_1 = P_2V_2 = C$ FOR P IN mm Hg AND V IN LITERS



Example No. 2:

What volume would a given quantity of a gas occupy at 200 mmHg and 80°C, when the same quantity of the gas occupies 4 liters at 500 mmHg and 80°C?

Ans: P_1V_1 = (500 mmHg) (4 liters) = 2000

Voulme = 10 liters

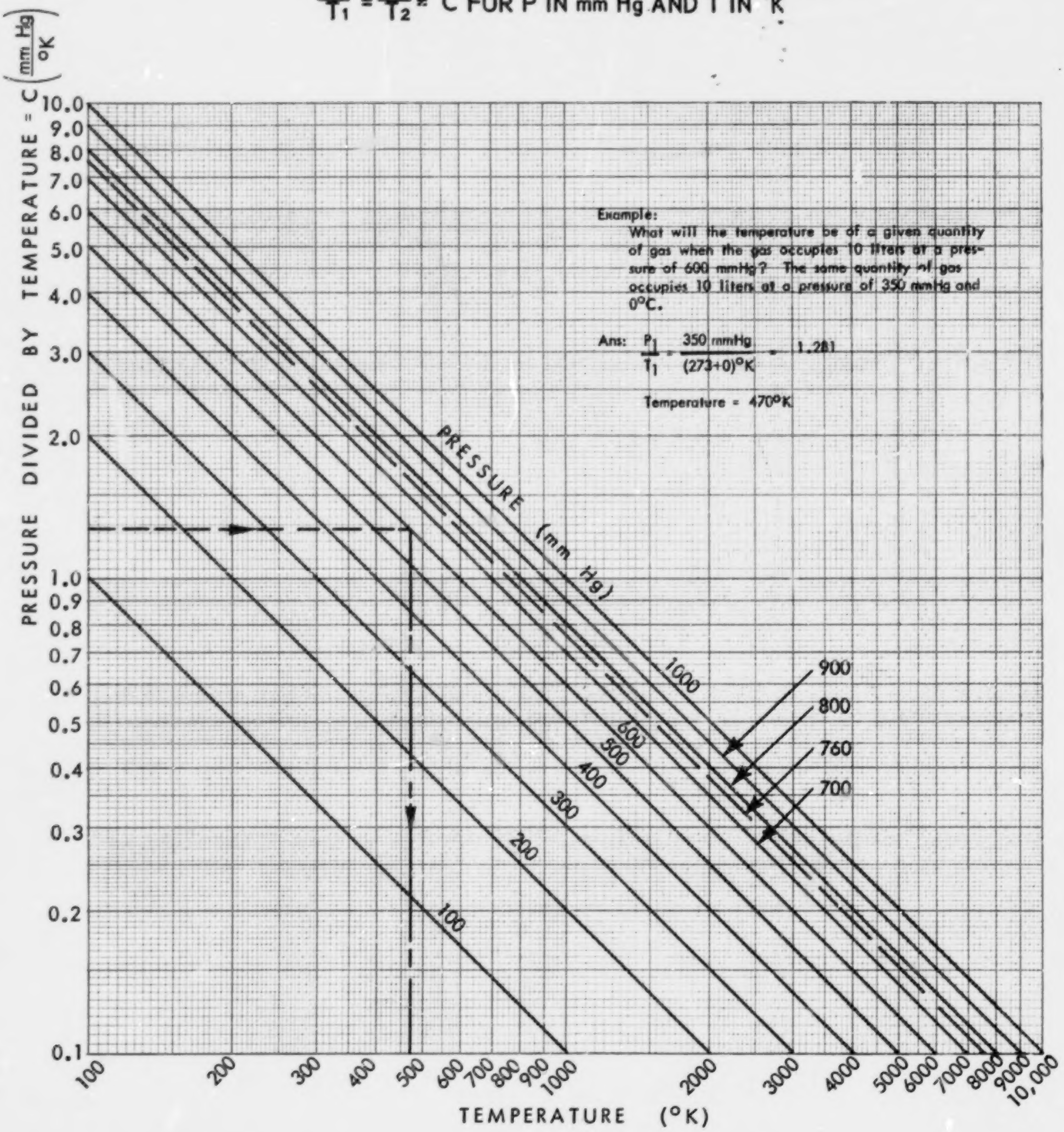
Example No. 1:

What volume would a given quantity of a gas occupy at 400 mmHg and 25°C, when the same quantity of the gas occupies 0.02 liters at 500 mmHg and 25°C?

Ans: P_1V_1 = (500 mmHg) (0.02 liters) = 10

Volume = 0.025

GRAPHICAL SOLUTION OF CHARLES LAW.
$\frac{P_1}{T_1} = \frac{P_2}{T_2} = C$ FOR P IN mm Hg AND T IN °K



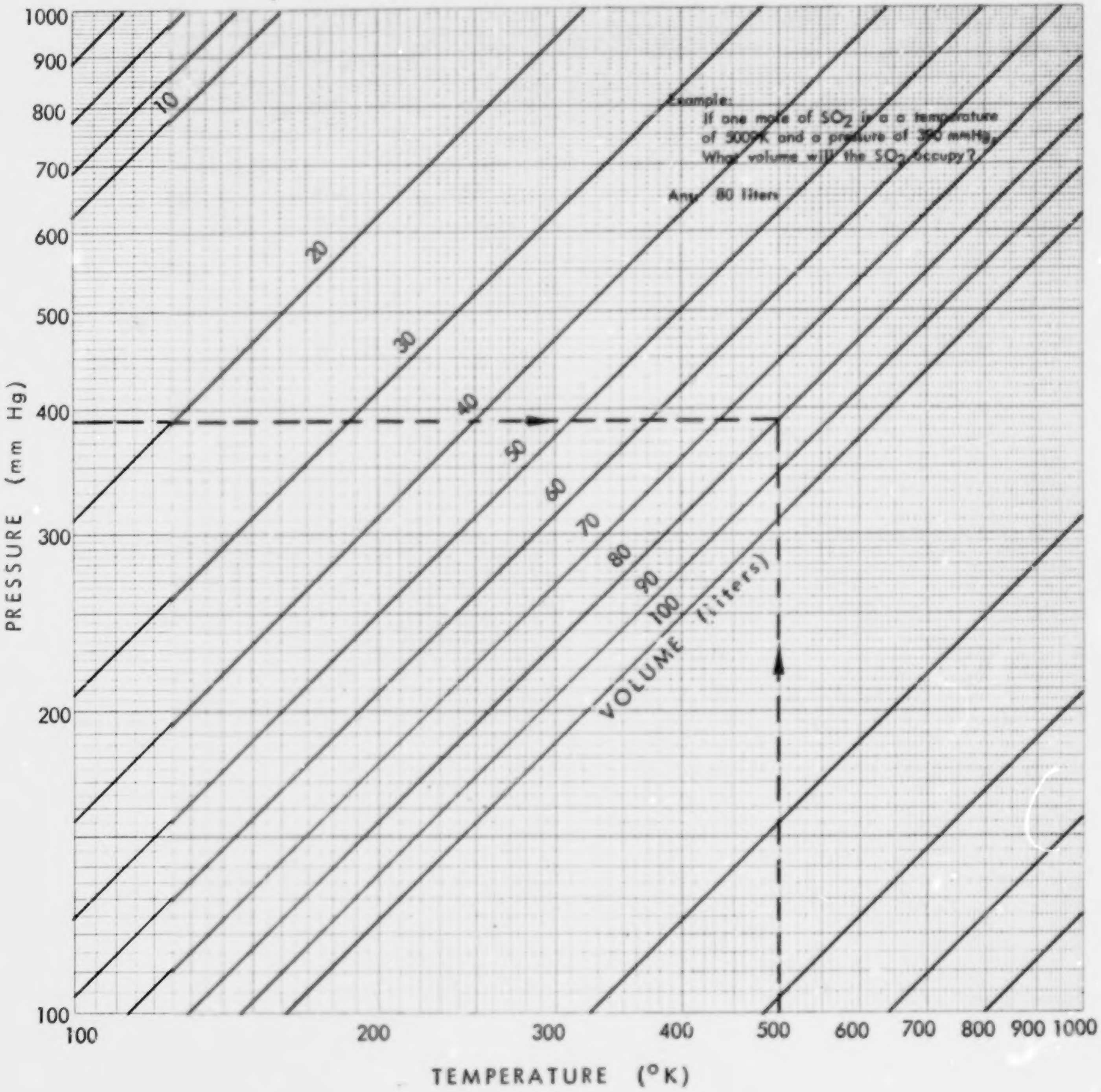
Example:
What will the temperature be of a given quantity of gas when the gas occupies 10 liters at a pressure of 600 mmHg? The same quantity of gas occupies 10 liters at a pressure of 350 mmHg and 0°C.

Ans: $\frac{P_1}{T_1} = \frac{350 \text{ mmHg}}{(273+0)°\text{K}} = 1.281$

Temperature = 470°K

GRAPHICAL SOLUTION OF "PERFECT GAS LAW" FOR ONE GRAM-MOLE OF GAS.

$\frac{PV}{T}$ = C FOR P IN mm Hg, V IN LITERS AND T IN °K


Example:
If one mole of SO_2 is a a temperature of 500°K and a pressure of 390 mmHg, What volume will the SO_2 occupy?

Ans. 80 liters

NOMOGRAPH FOR GAS EXPANSION
FOLLOWING PV^n = C, FOR P IN PSIA, V IN CUBIC FEET

Method for making calculations necessary for plotting gas expansion or compression curves, or for making other computations for determination of relationships between pressure and volume of a fixed amount of gas. The equation upon which the chart is based is the conventional one, where

$$PV^n = C$$

where P is pressure, V is volume, n is an exponent, and C is a figure that remains constant through any one series of computations.

Any units may be used for pressure and volume, but in any series of computations they must be consistent.

In arithmetical computation, the first step must be to set up the value of the constant upon the basis of original pressure and volume conditions and an assumed exponent. Then pressures may be computed for varying volumes, or volumes for varying pressures. Where the exponent is 1.0, which can happen only in theory, the arithmetical problem is simple. But the exponents applying to various gaseous materials under actual conditions are usually odd ones, making computation difficult and tedious. With the chart, however, it is a simple process.

Procedure. First, the value of the exponent is set, and then the vertical line scaled for this value on the chart is used throughout computations for the particular gas and general range of operations. The second step is then to note on this vertical line the intersection of the horizontal line scaled for the initial value of volume, interpolating as may be necessary. Then a straight line is established through this point and the scale point corresponding to the initial *Absolute Pressure* on the scale so designated.

The intersection of this line is then noted on the blank axis, and this point is used as a basis for further steps. Thus, to determine the new volume at some different pressure, a straight line is established through this point and the scale point for the new value on the *Absolute Pressure* scale. Then, on the vertical line corresponding to the assumed exponent value, at the intersection of the line just established, may be read the new value of volume.

By way of illustration, data may be obtained for plotting the expansion curve of a volume of gas beginning with an absolute pressure of 300 pounds per square inch and occupying a volume of 5.00 cubic feet, the exponent being set at 1.33. The first step, of course, is as described above, locating the vertical line corresponding to the exponent, interpolating as necessary.

Next, a straight line is established through the scale point *on this line*, corresponding to the *Volume*, 5.00, and the scale point for 300 on the *Absolute Pressure* scale. The intersection of the line so established with the central, blank axis is then noted and is used in subsequent operations in this particular problem.

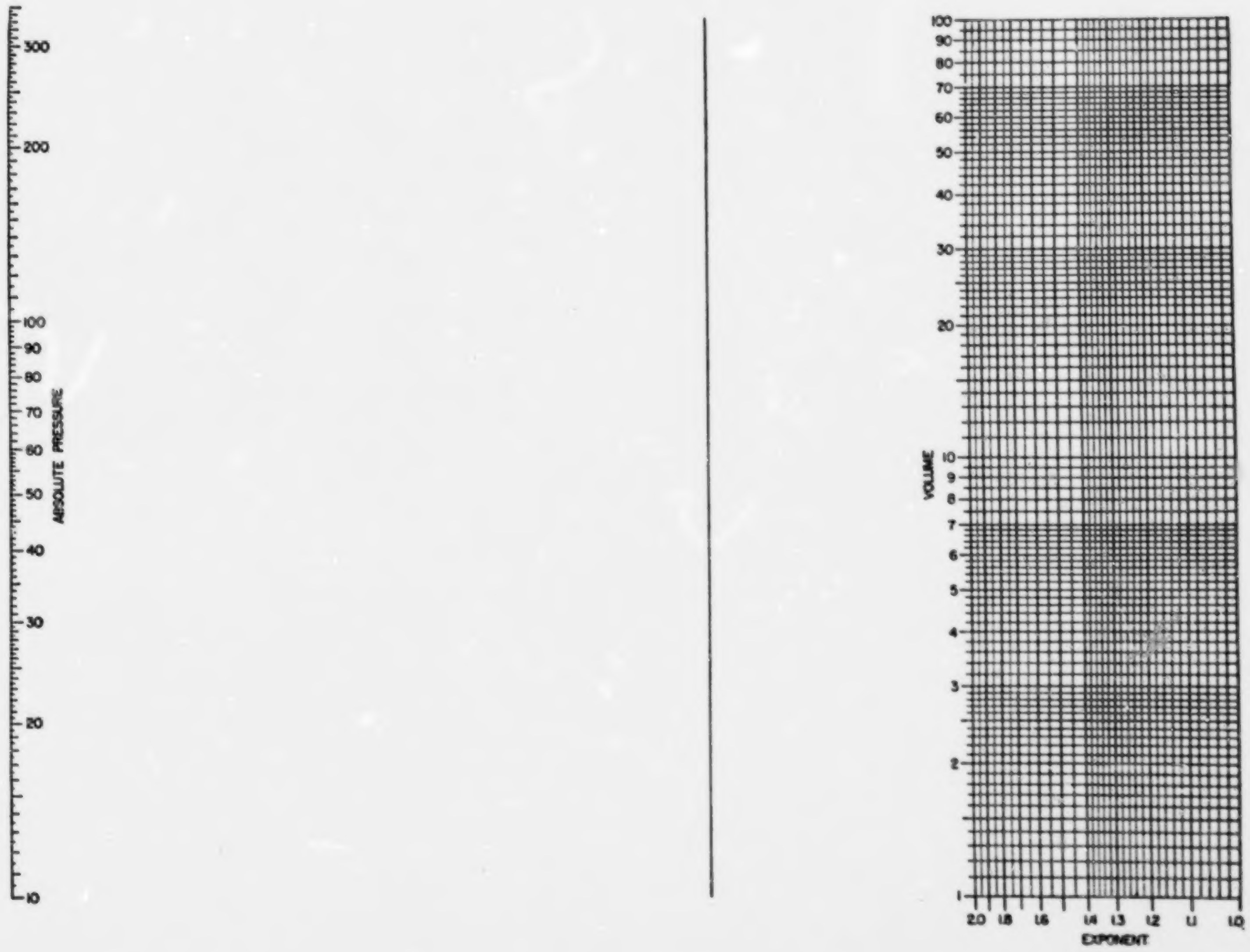
Now, the line is rotated about this point on the blank axis to find points on the expansion curve, and with one end fixed at any selected scale point on the *Absolute Pressure* scale, the corresponding *Volume* is read as the intercept of the horizontal scale lines on the vertical line of assumed exponent at the point of intersection of the rotating line. In this case, reading at absolute pressures of 150, 80, and 40, the corresponding volumes are 8.35, 13.2, and 22.4, where computation gave 8.39, 13.20, and 22.75.

It should be emphasized that operation of this chart differs from others in this collection in that the intercepts on the vertical lines are *not* carried to a fixed axis associated with the graph section.

See Reference No. 11

NOMOGRAPH FOR GAS EXPANSION
FOLLOWING $PV^n = C$, FOR P IN PSIA, V IN CUBIC FEET

(continued)



GRAPHICAL SOLUTION FOR DETERMINING DENSITY OF A GAS KNOWING P IN mm Hg, T IN °C, AND MOLECULAR WEIGHT

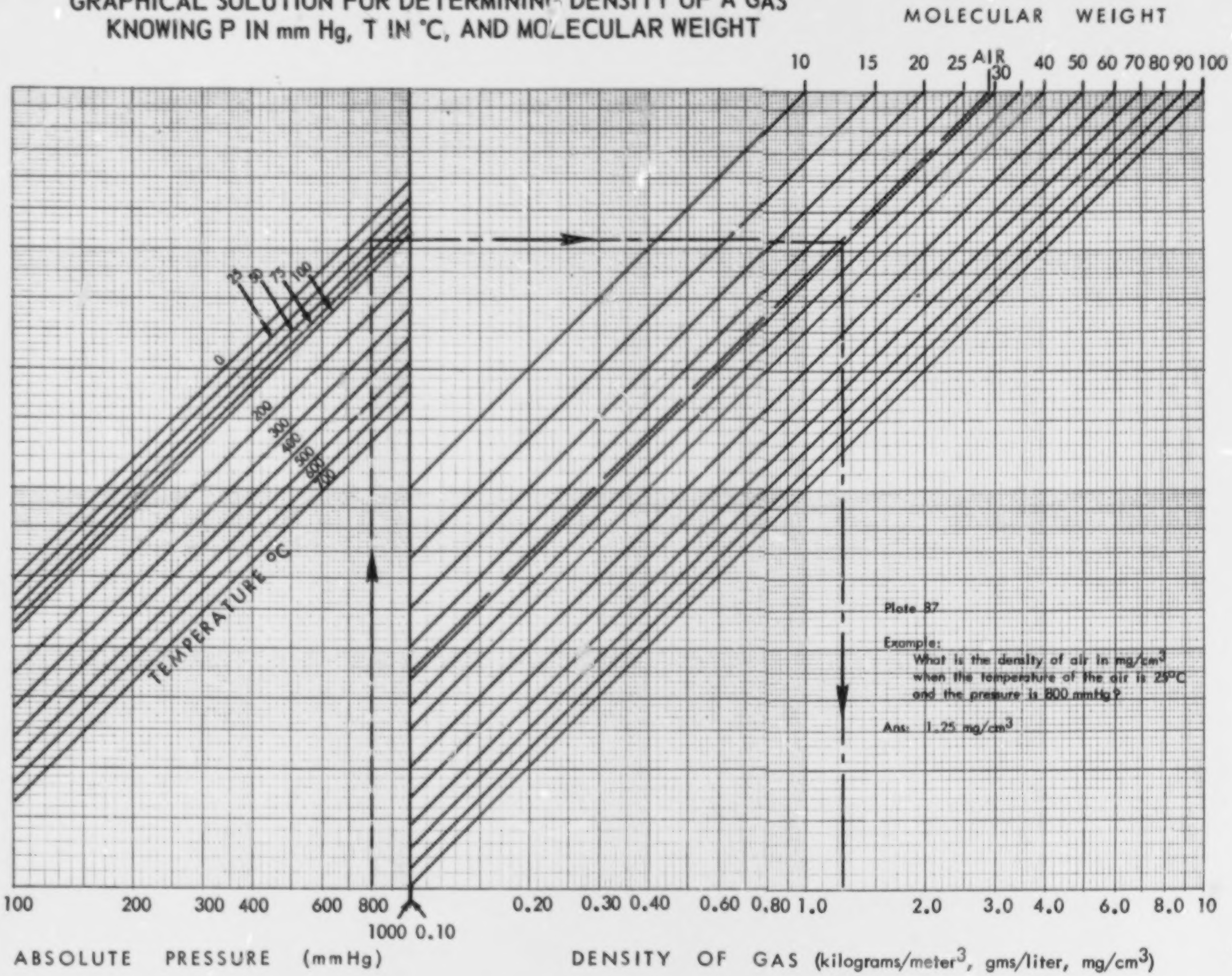
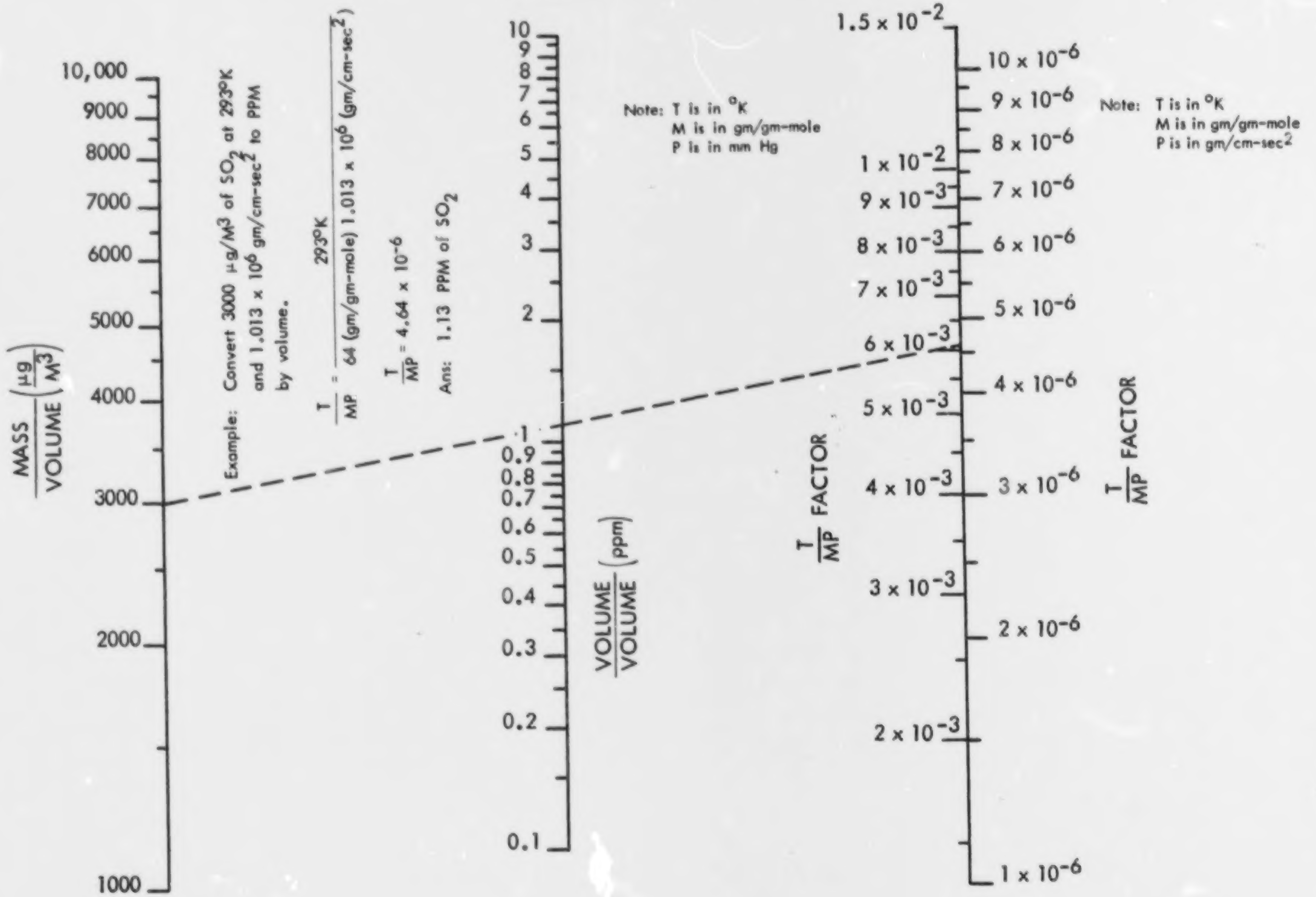


Plate 37

Example:
What is the density of air in mg/cm^3 when the temperature of the air is 25°C and the pressure is 800 mmHg?

Ans: 1.25 mg/cm^3

NOMOGRAPH FOR CONVERTING $\mu g/M^3$ TO PPM BY VOLUME KNOWING T IN °K, MOLECULAR WEIGHT, AND P IN $gm/cm\text{-}sec^2$ OR mm Hg



Example: Convert 3000 $\mu g/M^3$ of SO_2 at 293°K and 1.013×10^6 $gm/cm\text{-}sec^2$ to PPM by volume.

$$\frac{T}{MP} = \frac{293°K}{64\ (gm/gm\text{-}mole)\ 1.013 \times 10^6\ (gm/cm\text{-}sec^2)}$$

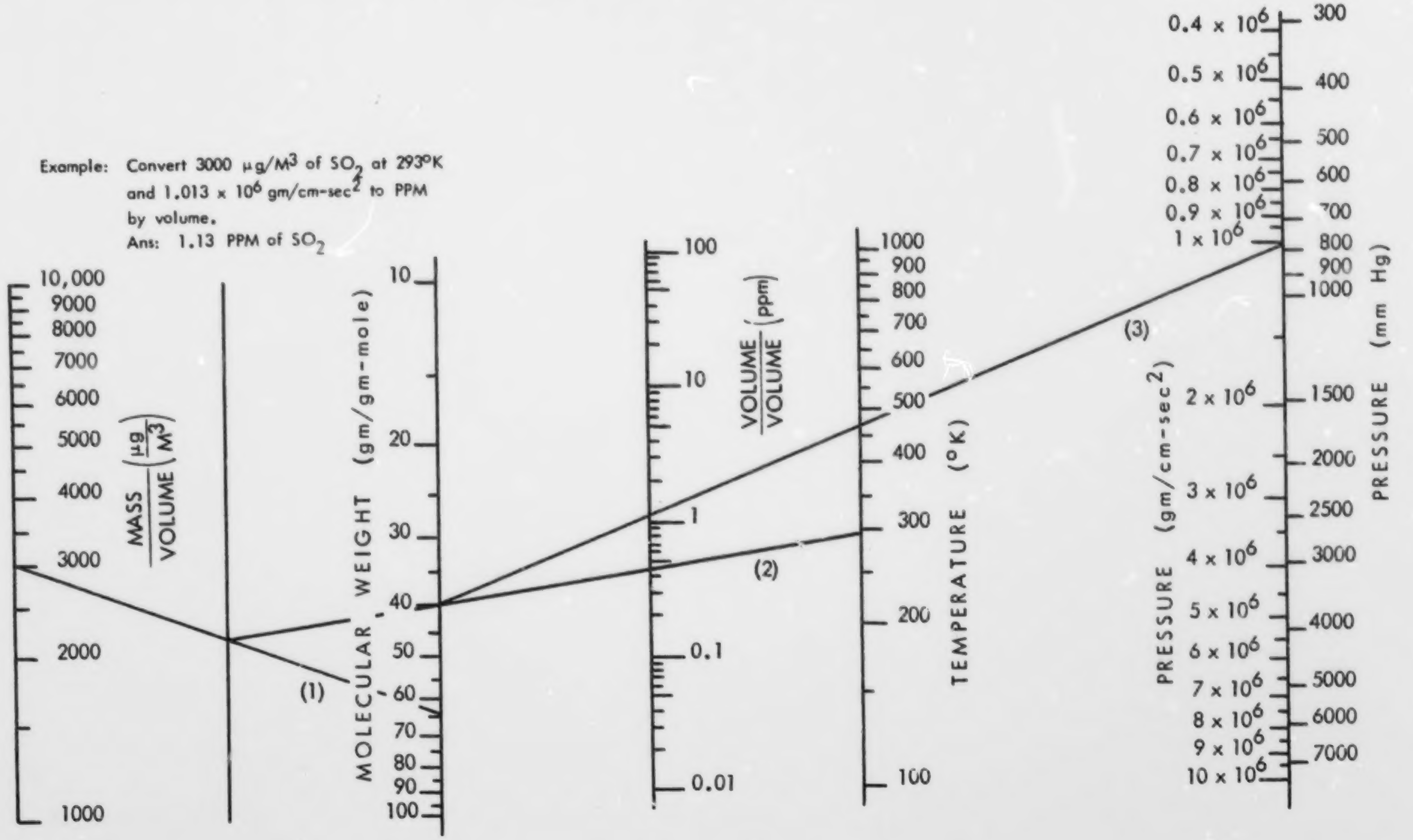
$$\frac{T}{MP} = 4.64 \times 10^{-6}$$

Ans: 1.13 PPM of SO_2

Note: T is in °K
M is in gm/gm-mole
P is in mm Hg

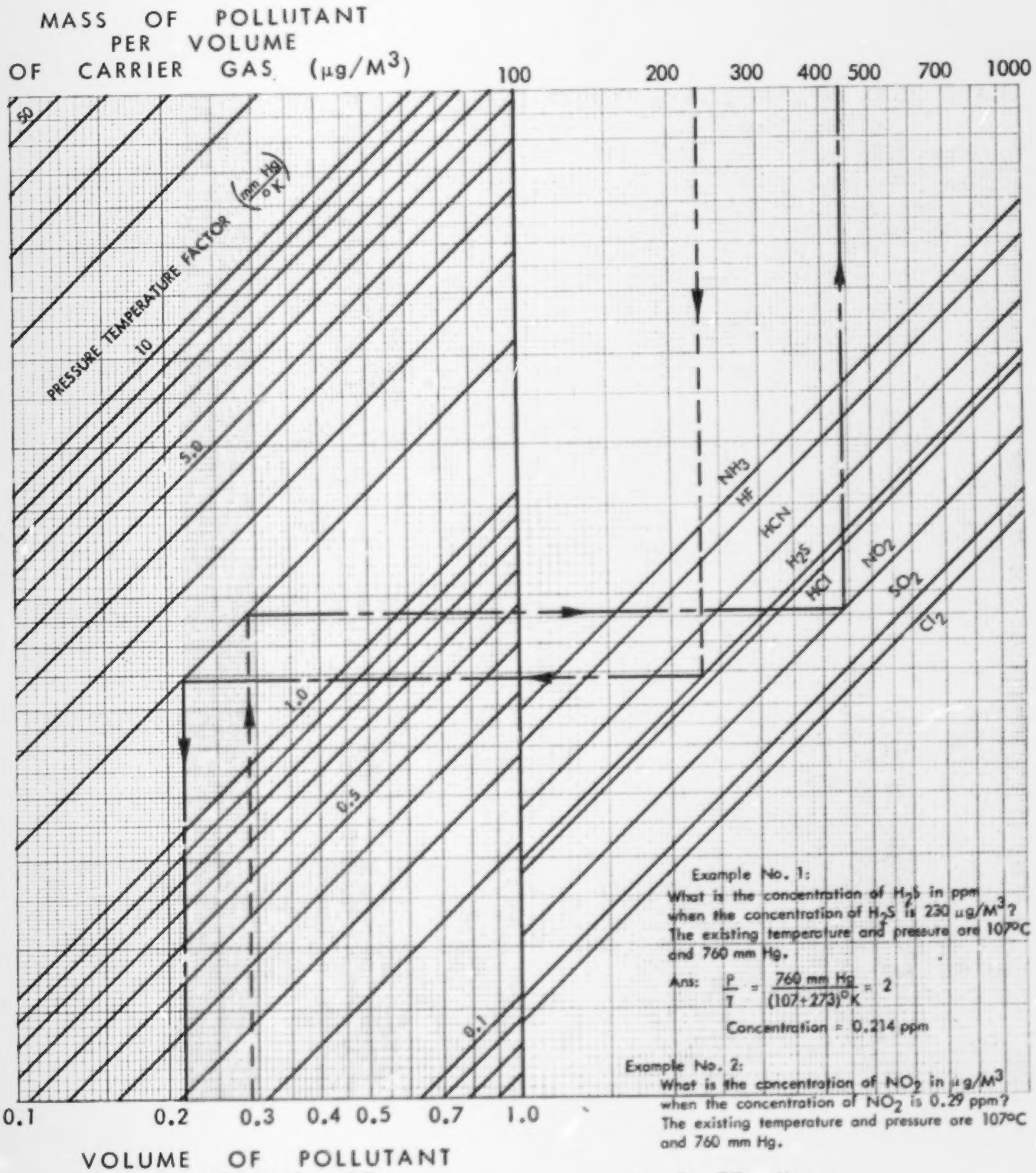
Note: T is in °K
M is in gm/gm-mole
P is in $gm/cm\text{-}sec^2$

NOMOGRAPH FOR CONVERTING µg/M³ TO PPM BY VOLUME KNOWING T IN °K, MOLECULAR WEIGHT, AND P IN gm/cm-sec² OR mm Hg



Example: Convert 3000 µg/M³ of SO_2 at 293°K and 1.013×10^6 gm/cm-sec² to PPM by volume.
Ans: 1.13 PPM of SO_2

GRAPH FOR CONVERTING $\mu g/M^3$ TO PPM BY VOLUME KNOWING P (mm Hg) AND T (°C OR °K) FOR Cl_2, SO_2, NO_2, HCl, H_2S, HCN, HF AND NH_3



Example No. 1:

What is the concentration of H_2S in ppm when the concentration of H_2S is 230 $\mu g/M^3$? The existing temperature and pressure are 107°C and 760 mm Hg.

Ans: $\frac{P}{T} = \frac{760 \text{ mm Hg}}{(107+273)^\circ K} = 2$

Concentration = 0.214 ppm

Example No. 2:

What is the concentration of NO_2 in $\mu g/M^3$ when the concentration of NO_2 is 0.29 ppm? The existing temperature and pressure are 107°C and 760 mm Hg.

Ans: $\frac{P}{T} = \frac{760 \text{ mm Hg}}{(107+273)^\circ K} = 2$

Concentration = 440 $\mu g/M^3$

VISCOSITIES OF GASES

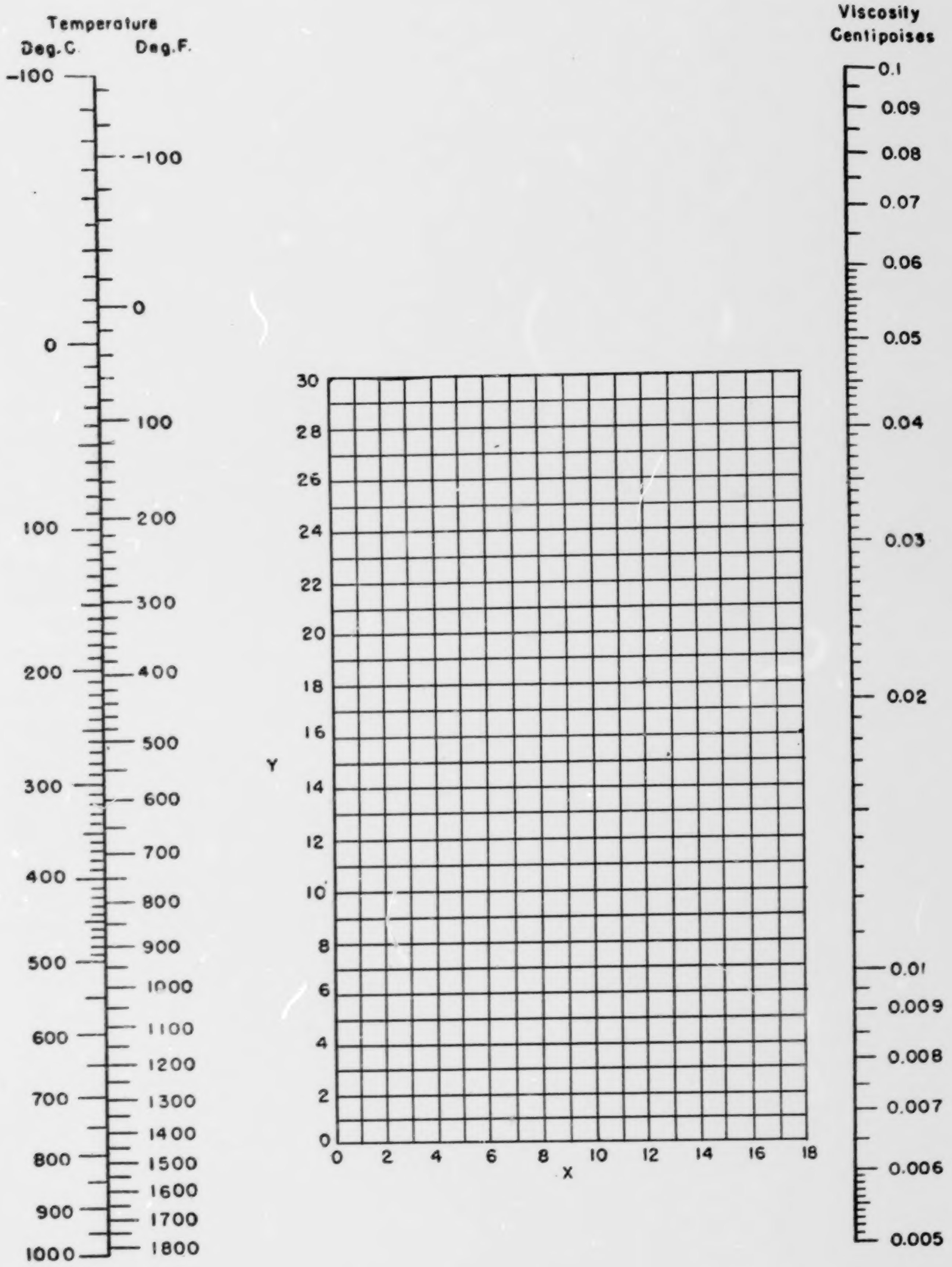
COORDINATES FOR USE WITH NOMOGRAPH

No.	Gas	X	Y	No.	Gas	X	Y
1	Acetic acid	7.7	14.3	29	Freon-113	11.3	14.0
2	Acetone	8.9	13.0	30	Helium	10.9	20.5
3	Acetylene	9.8	14.9	31	Hexane	8.6	11.8
4	Air	11.0	20.0	32	Hydrogen	11.2	12.4
5	Ammonia	8.4	16.0	33	$3H_2 + 1N_2$	11.2	17.2
6	Argon	10.5	22.4	34	Hydrogen bromide	8.8	20.9
7	Benzene	8.5	13.2	35	Hydrogen chloride	8.8	18.7
8	Bromine	8.9	19.2	36	Hydrogen cyanide	9.8	14.9
9	Butene	9.2	13.7	37	Hydrogen iodide	9.0	21.3
10	Butylene	8.9	13.0	38	Hydrogen sulfide	8.6	18.0
11	Carbon dioxide	9.5	18.7	39	Iodine	9.0	18.4
12	Carbon disulfide	8.0	16.0	40	Mercury	5.3	22.9
13	Carbon monoxide	11.0	20.0	41	Methane	9.9	15.5
14	Chlorine	9.0	18.4	42	Methyl alcohol	8.5	15.6
15	Chloroform	8.9	15.7	43	Nitric oxide	10.9	20.5
16	Cyanogen	9.2	15.2	44	Nitrogen	10.6	20.0
17	Cyclohexane	9.2	12.0	45	Nitrosyl chloride	8.0	17.6
18	Ethane	9.1	14.5	46	Nitrous oxide	8.8	19.0
19	Ethyl acetate	8.5	13.2	47	Oxygen	11.0	21.3
20	Ethyl alcohol	9.2	14.2	48	Pentane	7.0	12.8
21	Ethyl chloride	8.5	15.6	49	Propane	9.7	12.9
22	Ethyl ether	8.9	13.0	50	Propyl alcohol	8.4	13.4
23	Ethylene	9.5	15.1	51	Propylene	9.0	13.8
24	Fluorine	7.3	23.8	52	Sulfur dioxide	9.6	17.0
25	Freon-11	10.6	15.1	53	Toluene	8.6	12.4
26	Freon-12	11.1	16.0	54	2, 3, 3-Trimethylbutane	9.5	10.5
27	Freon-21	10.8	15.3	55	Water	8.0	16.0
28	Freon-22	10.1	17.0	56	Xenon	9.3	23.0

See Reference No. 10

VISCOSITIES OF GASES AT ONE ATMOSPHERE

FOR COORDINATES SEE TABLE ON PRECEDING PAGE



See Reference No. 10

MOLECULAR WEIGHTS OF SELECTED GASES

Gas	Formula	Molecular weight	Gas	Formula	Molecular weight
Acetylene	C_2H_2	26.04	Hydrogen	H_2	2.016
Ammonia	NH_3	17.03	Hydrogen fluoride	HF	20.01
Argon	A	39.944	Hydrogen sulfide	H_2S	34.08
Arsine	AsH_3	77.93	Krypton	Kr	83.7
Butane	C_4H_{10}	58.12	Methane	CH_4	16.04
Butene-1	C_4H_8	56.10	Neon	Ne	20.18
Carbon dioxide	CO_2	44.01	Nitric oxide	NO	30.01
Carbon disulfide	CS_2	76.14	Nitrogen	N_2	28.02
Carbon monoxide	CO	28.01	Nitrogen dioxide	NO_2	46.01
Chlorine	Cl_2	70.91	Nitrous oxide	N_2O	44.02
Ethane	C_2H_6	30.07	Oxygen	O_2	32.00
Ethene	C_2H_4	28.05	Ozone	O_3	48.00
Fluorine	F_2	38.00	Propane	C_3H_8	44.09
Formaldehyde	HCHO	30.03	Sulfur dioxide	SO_2	64.07
Helium	He	4.003	Sulfur trioxide	SO_3	80.07
Hydrogen chloride	HCl	36.47	Xenon	Xe	131.3

SPECIFIC HEAT RATIO OF GASES AT ONE ATMOSPHERE

Compound	Formula	Temperature, °C.	Ratio of specific heats, $(\gamma) = C_p/C_v$
Acetaldehyde	C_2H_4O	30	1.14
Acetic acid	$C_2H_4O_2$	136	1.15
Acetylene	C_2H_2	15	1.26
		−71	1.31
Air	....	925	1.36
		17	1.403
		−78	1.408
		−118	1.415
Ammonia	NH_3	15	1.310
Argon	A	15	1.668
		−180	1.76 (?)
		0–100	1.67
Benzene	C_6H_6	90	1.10
Bromine	Br_2	20–350	1.32
Carbon dioxide	CO_2	15	1.304
		−75	1.37
disulfide	CS_2	100	1.21
monoxide	CO	15	1.404
		−180	1.41
Chlorine	Cl_2	15	1.355
Chloroform	$CHCl_3$	100	1.15
Cyanogen	$(CN)_2$	15	1.256
Cyclohexane	C_6H_{12}	80	1.08
Dichlorodifluormethane	CCl_2F_2	25	1.139
Ethane	C_2H_6	100	1.19
		15	1.22
		−82	1.28
Ethyl alcohol	C_2H_6O	90	1.13
ether	$C_4H_{10}O$	35	1.08
		80	1.086
Ethylene	C_2H_4	100	1.18
		15	1.255
		−91	1.35
Helium	He	−180	1.660
Hexane (n-)	C_6H_{14}	80	1.08
Hydrogen	H_2	15	1.410
		−76	1.453
		−181	1.597
bromide	HBr	20	1.42
chloride	HCl	15	1.41
		100	1.40
cyanide	HCN	65	1.31
		140	1.28
		210	1.24
Hydrogen (*Cont.*):			
iodide	HI	20–100	1.40
sulfide	H_2S	15	1.32
		−45	1.30
		−57	1.29
Iodine	I_2	185	1.30
Isobutane	C_4H_{10}	15	1.11
Krypton	Kr	19	1.68
Mercury	Hg	360	1.67
Methane	CH_4	600	1.113
		300	1.16
		15	1.31
		−80	1.34
		−115	1.41
Methyl acetate	$C_3H_6O_2$	15	1.14
alcohol	CH_4O	77	1.203
ether	C_2H_6O	6–30	1.11
Methylal	$C_3H_8O_2$	13	1.06
		40	1.09
Neon	Ne	19	1.64
Nitric oxide	NO	15	1.400
		−45	1.39
		−80	1.38
Nitrogen	N_2	15	1.404
		−181	1.47
Nitrous oxide	N_2O	100	1.28
		15	1.303
		−30	1.31
		−70	1.34
Oxygen	O_2	15	1.401
		−76	1.415
		−181	1.45
Pentane (n-)	C_5H_{12}	86	1.086
Phosphorus	P	300	1.17
Potassium	K	850	1.77
Sodium	Na	750–920	1.68
Sulfur dioxide	SO_2	15	1.29
Xenon	Xe	19	1.66

See Reference No. 24

SECTION 13 PROPERTIES OF AIR

Density of Dry Air in Kg/M^3 for °C and Absolute Pressure in Millibars . . . 13-1

Density of Dry Air in Mg/cm^3 for °C and Absolute Pressure in mm. of Hg. . . 13-3

Density of Air (50% Saturated) in Milligrams per Milliliter for Various Temperatures in °C and Absolute Pressure in mm of Hg 13-4

Specific Weight of Dry Air in lbs/ft^3 for °F and °R and Absolute Pressure of 29.92 in. Hg – Graph 13-6

Specific Weight of Dry Air in lbs/ft^3 for °F and Absolute Pressure of 29.92 in. Hg – Table 13-7

Kinematic Viscosity (ft^2/sec) of Dry Air at an Absolute Pressure of 29.92 in Hg and Various Temperatures °F 13-7

Nomograph for Determining Theoretical Minimum Weight of Air Required for Combustion of a Fuel When the Chemical Analysis is Known 13-8

Viscosity of Air (Centipoises) at One Atmosphere for Various Temperatures °C and °F 13-10

Composition of Dry Air 13-11

Air Density Chart 13-12

DENSITY OF DRY AIR IN Kg/M³
FOR °C AND ABSOLUTE PRESSURE IN MILLIBARS

Adjusted virtual temperature t'_v	Pressure—millibars										
	1100	1000	900	800	700	600	500	400	300	200	100
°C.	kg. m.⁻³	kg. m.⁻³	kg. m.⁻³	kg. m.⁻³	kg. m.⁻³	kg. m.⁻³	kg. m.⁻³	kg. m.⁻³	kg. m.⁻³	kg. m.⁻³	kg. m.⁻³
0	1.4029	1.2754	1.1478	1.0203	0.8928	0.7652	0.6377	0.5102	0.3826	0.2551	0.1275
1	1.3978	1.2707	1.1437	1.0166	0.8895	0.7624	0.6354	0.5083	0.3812	0.2541	0.1271
2	1.3927	1.2661	1.1395	1.0129	0.8863	0.7597	0.6331	0.5064	0.3798	0.2532	0.1266
3	1.3877	1.2615	1.1354	1.0092	0.8831	0.7569	0.6308	0.5046	0.3785	0.2523	0.1262
4	1.3827	1.2570	1.1313	1.0056	0.8799	0.7542	0.6285	0.5028	0.3771	0.2514	0.1257
5	1.3777	1.2525	1.1272	1.0020	0.8767	0.7515	0.6262	0.5010	0.3757	0.2505	0.1252
6	1.3728	1.2480	1.1232	0.9984	0.8736	0.7488	0.6240	0.4992	0.3744	0.2496	0.1248
7	1.3679	1.2435	1.1192	0.9948	0.8705	0.7461	0.6218	0.4974	0.3731	0.2487	0.1244
8	1.3630	1.2391	1.1152	0.9913	0.8674	0.7435	0.6195	0.4956	0.3717	0.2478	0.1239
9	1.3582	1.2347	1.1112	0.9878	0.8643	0.7408	0.6174	0.4939	0.3704	0.2469	0.1235
10	1.3534	1.2303	1.1073	0.9843	0.8612	0.7382	0.6152	0.4921	0.3691	0.2461	0.1230
11	1.3486	1.2260	1.1034	0.9808	0.8582	0.7356	0.6130	0.4904	0.3678	0.2452	0.1226
12	1.3439	1.2217	1.0995	0.9774	0.8552	0.7330	0.6109	0.4887	0.3665	0.2443	0.1222
13	1.3392	1.2174	1.0957	0.9740	0.8522	0.7305	0.6087	0.4870	0.3652	0.2435	0.1217
14	1.3345	1.2132	1.0919	0.9706	0.8492	0.7279	0.6066	0.4853	0.3640	0.2426	0.1213
15	1.3299	1.2090	1.0881	0.9672	0.8463	0.7254	0.6045	0.4836	0.3627	0.2418	0.1209
16	1.3253	1.2048	1.0843	0.9638	0.8434	0.7229	0.6024	0.4819	0.3614	0.2410	0.1205
17	1.3207	1.2007	1.0806	0.9605	0.8405	0.7204	0.6003	0.4803	0.3602	0.2401	0.1201
18	1.3162	1.1965	1.0769	0.9572	0.8376	0.7179	0.5983	0.4786	0.3590	0.2393	0.1197
19	1.3117	1.1924	1.0732	0.9540	0.8347	0.7155	0.5962	0.4770	0.3577	0.2385	0.1192
20	1.3072	1.1884	1.0695	0.9507	0.8319	0.7130	0.5942	0.4753	0.3565	0.2377	0.1188
21	1.3028	1.1843	1.0659	0.9475	0.8290	0.7106	0.5922	0.4737	0.3553	0.2369	0.1184
22	1.2984	1.1803	1.0623	0.9443	0.8262	0.7082	0.5902	0.4721	0.3541	0.2361	0.1180
23	1.2940	1.1763	1.0587	0.9411	0.8234	0.7058	0.5882	0.4705	0.3529	0.2353	0.1176
24	1.2896	1.1724	1.0551	0.9379	0.8207	0.7034	0.5862	0.4690	0.3517	0.2345	0.1172
25	1.2853	1.1684	1.0516	0.9348	0.8179	0.7011	0.5842	0.4674	0.3505	0.2337	0.1168
26	1.2810	1.1645	1.0481	0.9316	0.8152	0.6987	0.5823	0.4658	0.3494	0.2329	0.1165
27	1.2767	1.1607	1.0446	0.9285	0.8125	0.6964	0.5803	0.4643	0.3482	0.2321	0.1161
28	1.2725	1.1568	1.0411	0.9254	0.8098	0.6941	0.5784	0.4627	0.3470	0.2314	0.1157
29	1.2683	1.1530	1.0377	0.9224	0.8071	0.6918	0.5765	0.4612	0.3459	0.2306	0.1153
30	1.2641	1.1492	1.0343	0.9193	0.8044	0.6895	0.5746	0.4597	0.3448	0.2298	0.1149
31	1.2599	1.1454	1.0309	0.9163	0.8018	0.6872	0.5727	0.4582	0.3435	0.2291	0.1145
32	1.2558	1.1416	1.0275	0.9133	0.7991	0.6850	0.5708	0.4567	0.3425	0.2283	0.1142
33	1.2517	1.1379	1.0241	0.9103	0.7965	0.6827	0.5690	0.4552	0.3414	0.2276	0.1138
34	1.2476	1.1342	1.0208	0.9074	0.7939	0.6805	0.5671	0.4537	0.3403	0.2268	0.1134
35	1.2436	1.1305	1.0175	0.9044	0.7914	0.6783	0.5653	0.4522	0.3392	0.2261	0.1131
36	1.2396	1.1269	1.0142	0.9015	0.7888	0.6761	0.5634	0.4507	0.3381	0.2254	0.1127
37	1.2356	1.1232	1.0109	0.8986	0.7863	0.6739	0.5616	0.4493	0.3370	0.2246	0.1123
38	1.2316	1.1196	1.0077	0.8957	0.7837	0.6718	0.5598	0.4479	0.3359	0.2239	0.1120
39	1.2276	1.1160	1.0044	0.8928	0.7812	0.6696	0.5580	0.4464	0.3348	0.2232	0.1116
40	1.2237	1.1125	1.0012	0.8900	0.7787	0.6675	0.5562	0.4450	0.3337	0.2225	0.1112
41	1.2198	1.1089	0.9980	0.8872	0.7763	0.6654	0.5545	0.4436	0.3327	0.2218	0.1109
42	1.2160	1.1054	0.9949	0.8843	0.7738	0.6633	0.5527	0.4422	0.3316	0.2211	0.1105
43	1.2121	1.1019	0.9917	0.8815	0.7713	0.6612	0.5510	0.4408	0.3306	0.2204	0.1102
44	1.2083	1.0984	0.9886	0.8788	0.7689	0.6591	0.5492	0.4394	0.3295	0.2197	0.1098
45	1.2045	1.0950	0.9855	0.8760	0.7665	0.6570	0.5475	0.4380	0.3285	0.2190	0.1095
46	1.2007	1.0916	0.9824	0.8732	0.7641	0.6549	0.5458	0.4366	0.3275	0.2183	0.1092
47	1.1970	1.0882	0.9793	0.8705	0.7617	0.6529	0.5441	0.4353	0.3264	0.2176	0.1088
48	1.1932	1.0848	0.9763	0.8678	0.7593	0.6509	0.5424	0.4339	0.3254	0.2170	0.1085
49	1.1895	1.0814	0.9733	0.8651	0.7570	0.6488	0.5407	0.4326	0.3244	0.2163	0.1081
50	1.1859	1.0780	0.9702	0.8624	0.7546	0.6468	0.5390	0.4312	0.3234	0.2156	0.1078

See Reference No. 1

DENSITY OF DRY AIR IN Kg/M^3
FOR °C AND ABSOLUTE PRESSURE IN MILLIBARS

(continued)

Adjusted virtual temperature t°, °C.	Pressure—millibars										
	1100	1000	900	800	700	600	500	400	300	200	100
	kg. m.$^{-3}$	kg. m.$^{-3}$	kg. m.$^{-3}$	kg. m.$^{-3}$	kg. m.$^{-3}$	kg. m.$^{-3}$	kg. m.$^{-3}$	kg. m.$^{-3}$	kg. m.$^{-3}$	kg. m.$^{-3}$	kg. m.$^{-3}$
50	1.1859	1.0780	0.9702	0.8624	0.7546	0.6468	0.5390	0.4312	0.3234	0.2156	0.1078
51	1.1822	0.0747	0.9673	0.8598	0.7523	0.6448	0.5374	0.4299	0.3224	0.2149	0.1075
52	1.1786	1.0714	0.9643	0.8571	0.7500	0.6429	0.5357	0.4286	0.3214	0.2143	0.1071
53	1.1750	1.0681	0.9613	0.8545	0.7477	0.6409	0.5341	0.4273	0.3204	0.2136	0.1068
54	1.1714	1.0649	0.9584	0.8519	0.7454	0.6389	0.5324	0.4259	0.3195	0.2130	0.1065
55	1.1678	1.0616	0.9555	0.8493	0.7431	0.6370	0.5308	0.4247	0.3185	0.2123	0.1062
56	1.1642	1.0584	0.9526	0.8467	0.7409	0.6350	0.5292	0.4234	0.3175	0.2117	0.1058
57	1.1607	1.0552	0.9497	0.8442	0.7386	0.6331	0.5276	0.4221	0.3166	0.2110	0.1055
58	1.1572	1.0520	0.9468	0.8416	0.7364	0.6312	0.5260	0.4208	0.3156	0.2104	0.1052
59	1.1537	1.0488	0.9440	0.8391	0.7342	0.6293	0.5244	0.4195	0.3147	0.2098	0.1049
60	1.1503	1.0457	0.9411	0.8366	0.7320	0.6274	0.5228	0.4183	0.3137	0.2091	0.1046
61	1.1468	1.0426	0.9383	0.8340	0.7298	0.6255	0.5213	0.4170	0.3128	0.2085	0.1043
62	1.1434	1.0394	0.9355	0.8316	0.7276	0.6237	0.5197	0.4158	0.3118	0.2079	0.1039
63	1.1400	1.0364	0.9327	0.8291	0.7255	0.6218	0.5182	0.4145	0.3109	0.2073	0.1036
64	1.1366	1.0333	0.9300	0.8266	0.7233	0.6200	0.5166	0.4133	0.3100	0.2067	0.1033
65	1.1333	1.0302	0.9272	0.8242	0.7212	0.6181	0.5151	0.4121	0.3091	0.2060	0.1030
66	1.1299	1.0272	0.9245	0.8218	0.7190	0.6163	0.5136	0.4109	0.3082	0.2054	0.1027
67	1.1266	1.0242	0.9218	0.8193	0.7169	0.6145	0.5121	0.4097	0.3073	0.2048	0.1024
68	1.1233	1.0212	0.9191	0.8169	0.7148	0.6127	0.5106	0.4085	0.3064	0.2042	0.1021
69	1.1200	1.0182	0.9164	0.8146	0.7127	0.6109	0.5091	0.4073	0.3055	0.2036	0.1018
70	1.1167	1.0152	0.9137	0.8122	0.7107	0.6091	0.5076	0.4061	0.3046	0.2030	0.1015
71	1.1135	1.0123	0.9110	0.8098	0.7086	0.6074	0.5061	0.4049	0.3037	0.2025	0.1012
72	1.1103	1.0093	0.9084	0.8075	0.7065	0.6056	0.5047	0.4037	0.3028	0.2019	0.1009
73	1.1071	1.0064	0.9058	0.8051	0.7045	0.6039	0.5032	0.4026	0.3019	0.2013	0.1006
74	1.1039	1.0035	0.9032	0.8028	0.7025	0.6021	0.5018	0.4014	0.3011	0.2007	0.1004
75	1.1007	1.0006	0.9006	0.8005	0.7004	0.6004	0.5003	0.4003	0.3002	0.2001	0.1001
76	1.0976	0.9978	0.8980	0.7982	0.6984	0.5987	0.4989	0.3991	0.2993	0.1996	0.0998
77	1.0944	0.9949	0.8954	0.7959	0.6965	0.5970	0.4975	0.3980	0.2985	0.1990	0.0995
78	1.0913	0.9921	0.8929	0.7937	0.6945	0.5953	0.4960	0.3968	0.2976	0.1984	0.0992
79	1.0882	0.9893	0.8904	0.7914	0.6925	0.5936	0.4946	0.3957	0.2968	0.1979	0.0989
80	1.0851	0.9865	0.8878	0.7892	0.6905	0.5919	0.4932	0.3946	0.2959	0.1973	0.0986
81	1.0821	0.9837	0.8853	0.7870	0.6886	0.5902	0.4918	0.3935	0.2951	0.1967	0.0984
82	1.0790	0.9809	0.8828	0.7847	0.6866	0.5886	0.4905	0.3924	0.2943	0.1962	0.0981
83	1.0760	0.9782	0.8804	0.7825	0.6847	0.5869	0.4891	0.3913	0.2935	0.1956	0.0978
84	1.0730	0.9754	0.8779	0.7803	0.6828	0.5853	0.4877	0.3902	0.2926	0.1951	0.0975
85	1.0700	0.9727	0.8754	0.7782	0.6809	0.5836	0.4864	0.3891	0.2918	0.1945	0.0973
86	1.0670	0.9700	0.8730	0.7760	0.6790	0.5820	0.4850	0.3880	0.2910	0.1940	0.0970
87	1.0640	0.9673	0.8706	0.7738	0.6771	0.5804	0.4836	0.3869	0.2902	0.1935	0.0967
88	1.0611	0.9646	0.8682	0.7717	0.6752	0.5788	0.4823	0.3858	0.2894	0.1929	0.0965
89	1.0582	0.9620	0.8658	0.7696	0.6734	0.5772	0.4810	0.3848	0.2886	0.1924	0.0962
90	1.0552	0.9593	0.8634	0.7674	0.6715	0.5756	0.4797	0.3837	0.2878	0.1919	0.0959
91	1.0523	0.9567	0.8610	0.7653	0.6697	0.5740	0.4783	0.3827	0.2870	0.1913	0.0957
92	1.0495	0.9541	0.8587	0.7632	0.6678	0.5724	0.4770	0.3816	0.2862	0.1908	0.0954
93	1.0466	0.9514	0.8563	0.7612	0.6660	0.5709	0.4757	0.3806	0.2854	0.1903	0.0951
94	1.0437	0.9489	0.8540	0.7591	0.6642	0.5693	0.4744	0.3795	0.2847	0.1898	0.0949
95	1.0409	0.9463	0.8517	0.7570	0.6624	0.5678	0.4731	0.3785	0.2839	0.1893	0.0946
96	1.0381	0.9437	0.8493	0.7550	0.6606	0.5662	0.4719	0.3775	0.2831	0.1887	0.0944
97	1.0353	0.9412	0.8471	0.7529	0.6588	0.5647	0.4706	0.3765	0.2824	0.1882	0.0941
98	1.0325	0.9386	0.8448	0.7509	0.6570	0.5632	0.4693	0.3755	0.2816	0.1877	0.0939
99	1.0297	0.9361	0.8425	0.7489	0.6553	0.5617	0.4681	0.3744	0.2808	0.1872	0.0936
100	1.0270	0.9336	0.8402	0.7469	0.6535	0.5602	0.4668	0.3734	0.2801	0.1867	0.0934

DENSITY OF DRY AIR IN mg/cm³ FOR °C AND ABSOLUTE PRESSURE IN mm. OF Hg

This table gives the density at different temperatures of dry air containing about 0.04 per cent of CO_2 (which is an average value for the CO_2 content), the values being computed from the formula

$$C = \frac{1.293052}{1 + 0.00367\,t} \times \frac{h}{760}$$

where h is pressure in millimeters of mercury at 0° C and standard gravity, and t is temperature in degrees centigrade.

Temperature in degrees centigrade.	Pressure in millimeters of Hg (0° C, standard gravity)											
	720	725	730	735	740	745	750	755	760	765	770	775
15	1.1611	1.1691	1.1772	1.1853	1.1933	1.2014	1.2095	1.2175	1.2256	1.2336	1.2417	1.2498
16	1.1571	1.1651	1.1731	1.1812	1.1892	1.1972	1.2053	1.2133	1.2213	1.2294	1.2374	1.2454
17	1.1531	1.1611	1.1691	1.1771	1.1851	1.1931	1.2011	1.2091	1.2171	1.2251	1.2331	1.2411
18	1.1491	1.1571	1.1650	1.1730	1.1810	1.1890	1.1970	1.2049	1.2129	1.2209	1.2289	1.2369
19	1.1451	1.1531	1.1611	1.1690	1.1770	1.1849	1.1929	1.2008	1.2088	1.2167	1.2247	1.2326
20	1.1412	1.1492	1.1571	1.1650	1.1729	1.1809	1.1888	1.1967	1.2046	1.2126	1.2205	1.2284
21	1.1373	1.1452	1.1531	1.1610	1.1689	1.1768	1.1847	1.1926	1.2005	1.2084	1.2163	1.2242
22	1.1335	1.1414	1.1492	1.1571	1.1650	1.1728	1.1807	1.1886	1.1965	1.2043	1.2122	1.2201
23	1.1296	1.1375	1.1453	1.1532	1.1610	1.1689	1.1767	1.1846	1.1924	1.2002	1.2081	1.2159
24	1.1258	1.1337	1.1415	1.1493	1.1571	1.1649	1.1727	1.1806	1.1884	1.1962	1.2040	1.2118
25	1.1220	1.1298	1.1376	1.1454	1.1532	1.1610	1.1688	1.1766	1.1844	1.1922	1.2000	1.2078
26	1.1183	1.1261	1.1338	1.1416	1.1494	1.1571	1.1649	1.1727	1.1804	1.1882	1.1959	1.2037
27	1.1146	1.1223	1.1300	1.1378	1.1455	1.1533	1.1610	1.1687	1.1765	1.1842	1.1920	1.1997
28	1.1108	1.1186	1.1263	1.1340	1.1417	1.1494	1.1571	1.1648	1.1726	1.1803	1.1880	1.1957
29	1.1072	1.1149	1.1225	1.1302	1.1379	1.1456	1.1533	1.1610	1.1687	1.1764	1.1840	1.1917
30	1.1035	1.1112	1.1188	1.1265	1.1342	1.1418	1.1495	1.1571	1.1648	1.1725	1.1801	1.1878
31	1.0999	1.1075	1.1151	1.1228	1.1304	1.1381	1.1457	1.1533	1.1610	1.1686	1.1762	1.1839

See Reference No. 3

DENSITY OF AIR (50% SATURATED) IN MILLIGRAMS PER MILLILITER FOR VARIOUS TEMPERATURES IN °C AND ABSOLUTE PRESSURE IN mm OF Hg

This table is from Theorie, Konstruktion und Gebrauch der Feineren Hebelwage, by W. Felgentraeger. It is computed for air of 50 per cent relative humidity and for a place where "g" equals 981.288 cm/sec^2. Ordinary changes from these conditions may be expected to introduce errors of about five units in the last decimal place given. If more accurate results are required, reductions or corrections must be applied[18] as noted below the table.

The barometer readings should be corrected for instrumental errors such as errors of the scale or residual gas pressure if these errors are not neglible. The reductions for temperature and for gravity (latitude and elevation) are included in the computation of the table. The temperature used must be that at the balance case; the temperature of the barometer should not differ from this by more than 5°.

T b	16°	17°	18°	19°	20°	21°	22°	23°	24°	25°	26°	27°	28°
690	1.103	099	094	090	086	082	077	073	069	065	061	057	052
1	104	100	096	092	087	083	079	075	071	066	062	058	054
2	106	102	097	093	089	085	081	076	072	068	064	060	055
3	108	103	099	095	091	086	082	078	074	070	065	061	057
4	109	105	101	096	092	088	084	080	075	071	067	063	059
5	111	106	102	098	094	089	085	081	077	073	068	064	060
6	112	108	104	099	095	091	087	083	078	074	070	066	062
7	114	110	105	101	097	093	088	084	080	076	072	067	063
8	116	111	107	103	098	094	090	086	082	077	073	069	065
9	117	113	109	104	100	096	092	087	083	079	075	070	066
700	1.119	115	110	106	102	097	093	089	085	080	076	072	068
1	120	116	112	107	103	099	095	090	086	082	078	074	069
2	122	118	113	109	105	100	096	092	088	084	079	075	071
3	124	119	115	111	106	102	098	094	089	085	081	077	072
4	125	121	117	112	108	104	099	095	091	087	082	078	074
5	127	123	118	114	110	105	101	097	092	088	084	080	076
6	128	124	120	115	111	107	[illegible]	098	094	090	085	081	077
7	130	126	121	117	113	108	104	100	096	091	087	083	078
8	132	127	123	118	114	110	106	101	097	093	089	084	080
9	133	129	125	120	116	112	107	103	099	094	090	086	082
710	1.135	130	126	122	117	113	109	105	100	096	092	087	083
1	136	132	128	123	119	115	110	106	102	097	093	089	085
2	138	134	129	125	121	116	112	108	103	099	095	090	086
3	140	135	131	127	122	118	114	109	105	101	096	092	088
4	141	137	132	128	124	119	115	111	106	102	098	094	089
5	143	138	134	130	125	121	117	112	108	104	099	095	091
6	144	140	136	131	127	123	118	114	110	105	101	097	092
7	146	142	137	133	128	124	120	115	111	107	102	098	094
8	148	143	139	134	130	126	121	117	113	108	104	100	095
9	149	144	140	136	132	127	123	119	114	110	106	101	097
720	1.151	146	142	138	133	129	124	120	116	111	107	103	099
1	152	148	144	139	135	130	126	122	117	113	109	104	100
2	154	150	145	141	136	132	128	123	119	114	110	106	102
3	156	151	147	142	138	134	129	125	120	116	112	107	103
4	157	153	148	144	140	135	131	126	122	118	113	109	105
5	159	154	150	145	141	137	132	128	124	119	115	111	106
6	160	156	151	147	143	138	134	130	125	121	116	112	108
7	162	158	153	149	144	140	136	131	127	122	118	114	109
8	164	159	155	150	146	141	137	133	128	124	120	115	111
9	165	161	156	152	147	143	139	134	130	125	121	117	112
730	1.167	162	158	153	149	145	140	136	131	127	123	118	114
1	169	164	160	155	151	146	142	137	133	129	124	120	115
2	170	166	161	157	152	148	143	139	135	130	126	121	117
3	172	167	163	158	154	149	145	140	136	132	127	123	119
4	173	169	164	160	155	151	147	142	138	133	129	124	120
5	175	170	166	161	157	153	148	144	139	135	130	126	122
6	177	172	168	163	159	154	150	145	141	136	132	128	123
7	178	174	169	165	160	156	151	147	142	138	133	129	125
8	180	175	171	166	162	157	153	148	144	139	135	131	126
9	181	177	172	168	163	159	154	150	145	141	136	132	128
740	1.183	178	174	169	165	160	156	151	147	142	138	134	129

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[18] When a large number of corrections or reductions must be introduced it is generally as easy and often preferable for other reasons to determine the density from other tables.

DENSITY OF AIR (50% SATURATED) IN MILLIGRAMS PER MILLILITER FOR VARIOUS TEMPERATURES IN °C AND ABSOLUTE PRESSURE IN mm OF Hg

(continued)

t b	16°	17°	18°	19°	20°	21°	22°	23°	24°	25°	26°	27°	28°
740	1.183	178	174	169	165	160	156	151	147	142	138	134	129
1	185	180	176	171	166	162	157	153	148	144	140	135	131
2	186	182	177	173	168	164	159	155	150	146	141	137	132
3	188	183	179	174	170	165	161	156	152	147	143	138	134
4	189	185	180	176	171	167	162	158	153	149	144	140	136
5	191	186	182	177	173	168	164	159	155	150	146	141	137
6	193	188	183	179	174	170	165	161	156	152	147	143	139
7	194	190	185	180	176	171	167	162	158	153	149	144	140
8	196	191	187	182	177	173	168	164	159	155	150	146	142
9	197	193	188	184	179	175	170	166	161	157	152	148	143
750	1.199	194	190	185	181	176	172	167	163	158	154	149	145
1	201	196	191	187	182	178	173	169	164	160	155	151	146
2	202	198	193	188	184	179	175	170	166	161	157	152	148
3	204	199	195	190	185	181	176	172	167	163	158	154	149
4	205	201	196	192	187	182	178	173	169	164	160	155	151
5	207	202	198	193	189	184	179	175	170	166	161	157	152
6	209	204	199	195	190	186	181	177	172	167	162	158	154
7	210	206	201	196	192	187	183	178	174	169	164	160	155
8	212	207	203	198	193	189	184	180	175	171	166	161	157
9	213	209	204	200	195	190	186	181	177	172	168	163	158
760	1.215	210	206	201	196	192	187	183	178	174	169	165	160
1	217	212	207	203	198	193	189	184	180	175	171	166	162
2	218	214	209	204	200	195	190	186	181	177	172	168	163
3	220	215	211	206	201	197	192	187	183	178	174	169	165
4	221	217	212	208	203	198	194	189	184	180	175	171	166
5	223	218	214	209	204	200	195	191	186	181	177	172	168
6	225	220	215	211	206	201	197	192	188	183	178	174	169
7	226	222	217	212	208	203	198	194	189	184	180	175	171
8	228	223	219	214	209	204	200	195	191	186	181	177	172
9	230	225	220	215	211	206	201	197	192	188	183	178	174
770	1.231	226	222	217	212	208	203	198	194	189	185	180	175
1	233	228	223	219	214	209	205	200	195	191	186	182	177
2	234	230	225	220	215	211	206	201	197	192	188	183	178
3	236	231	227	222	217	212	208	203	198	193	189	185	180
4	238	233	228	223	219	214	209	205	200	195	191	186	182
5	239	234	230	225	220	216	211	206	202	197	192	188	183
6	241	236	231	227	222	217	212	208	203	198	194	189	185
7	242	238	233	228	223	219	214	209	205	200	195	191	186
8	244	239	234	230	225	220	216	211	206	202	197	192	188
9	246	241	236	231	227	222	217	213	208	203	199	194	189
780	247	242	238	233	228	223	219	214	209	205	200	195	191

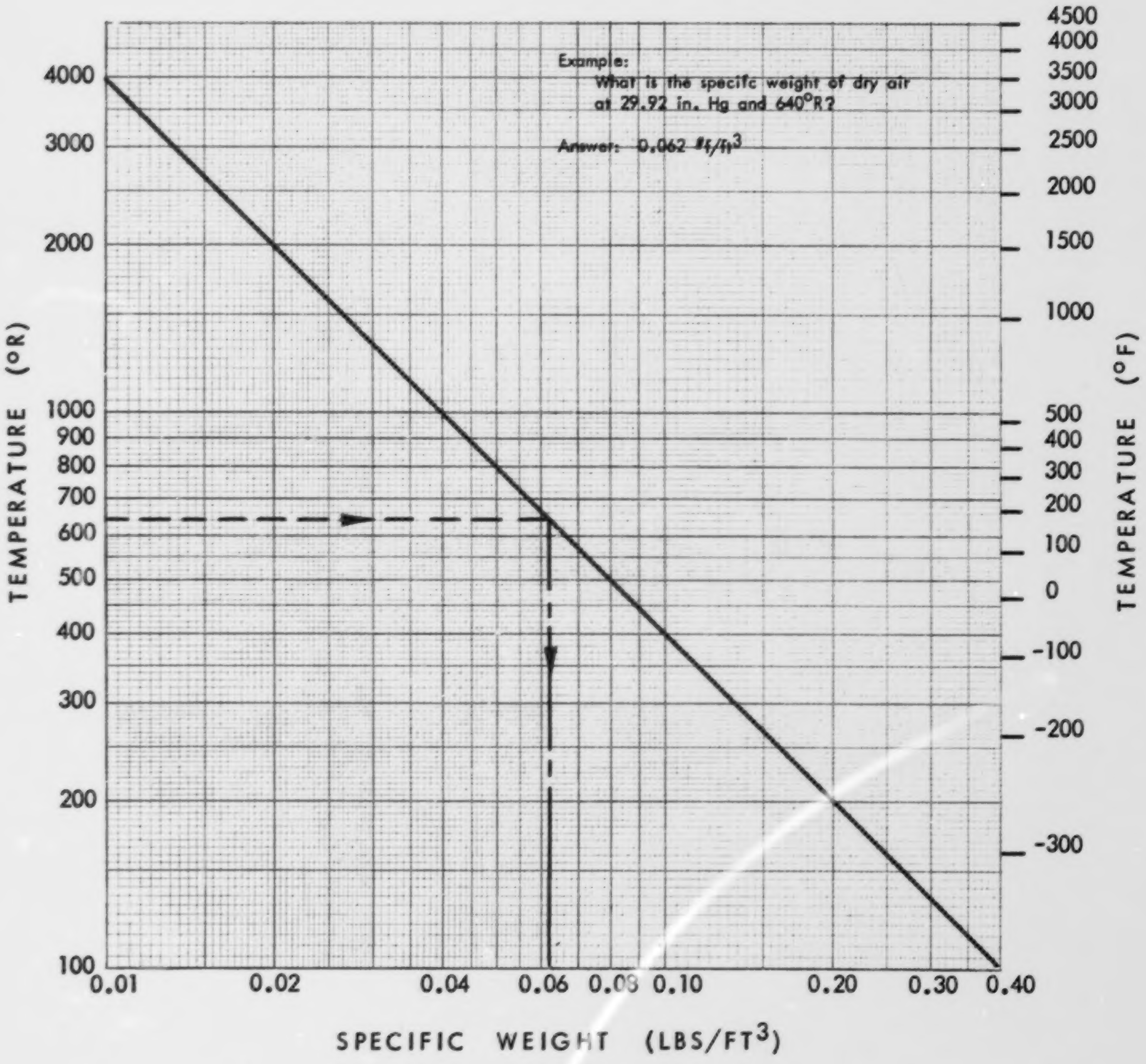
Interpolation Table

Δτ Δb	0.0°	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
mm										
0.0	0	− 0	− 1	− 1	− 2	− 2	− 3	− 3	− 4	− 4
0.1	+ 0	− 0	− 1	− 1	− 2	− 2	− 3	− 3	− 4	− 4
0.2	+ 0	− 0	− 1	− 1	− 2	− 2	− 2	− 3	− 4	− 4
0.3	+ 0	+ 0	− 0	− 1	− 1	− 2	− 2	− 3	− 3	− 4
0.4	+ 1	+ 0	− 0	− 1	− 1	− 2	− 2	− 3	− 3	− 4
0.5	+ 1	+ 0	− 0	− 1	− 1	− 2	− 2	− 2	− 3	− 3
0.6	+ 1	+ 0	+ 0	− 0	− 1	− 1	− 2	− 2	− 3	− 3
0.7	+ 1	+ 1	+ 0	− 0	− 1	− 1	− 2	− 2	− 3	− 3
0.8	+ 1	+ 1	+ 0	− 0	− 1	− 1	− 2	− 2	− 2	− 3
0.9	+ 1	+ 1	+ 0	+ 0	− 0	− 1	− 2	− 1	− 2	− 3

Humidity Correction

Per cent t	10	20	30	40	50	60	70	80	90	100
°C										
10	+2	+2	+1	+1	0	−1	−1	−2	−2	−3
20	+4	+3	+2	+1	0	−1	−2	−3	−4	−5
30	+7	+6	+4	+2	0	−2	−4	−6	−7	−9

SPECIFIC WEIGHT OF DRY AIR IN lbs/ft³ FOR °F AND °R AND ABSOLUTE PRESSURE OF 29.92 in. Hg



Example:
What is the specifc weight of dry air at 29.92 in. Hg and 640°R?

Answer: 0.062 #/ft³

SPECIFIC WEIGHT OF DRY AIR IN lbs/ft^3 FOR °F AND ABSOLUTE PRESSURE OF 29.92 in.Hg

Temperature (°F)	Specific weight (lbs/ft^3)	Temperature (°F)	Specific weight (lbs/ft^3)
0	0.08633	180	0.06203
10	0.08449	200	0.06015
20	0.08273	220	0.05838
30	0.08104	240	0.05671
40	0.07942	260	0.05514
50	0.07785	280	0.05365
60	0.07636	300	0.05223
70	0.07492	350	0.04901
80	0.07353	400	0.04615
90	0.07219	450	0.04362
100	0.07090	500	0.04135
110	0.06966	550	0.03930
120	0.06845	600	0.03744
130	0.06729	700	0.03422
140	0.06617	800	0.03150
150	0.06509	900	0.02911
160	0.06403	1000	0.02718

KINEMATIC VISCOSITY (ft^2/sec) OF DRY AIR AT AN ABSOLUTE PRESSURE OF 29.92 in. Hg AND VARIOUS TEMPERATURES °F

Temperature (°F)	Kinematic viscosity (ft^2/sec)
0	1.26 (10)$^{-4}$
20	1.36 (10)$^{-4}$
40	1.46 (10)$^{-4}$
60	1.58 (10)$^{-4}$
80	1.69 (10)$^{-4}$
100	1.80 (10)$^{-4}$
120	1.89 (10)$^{-4}$
150	2.07 (10)$^{-4}$
200	2.4 (10)$^{-4}$

NOMOGRAPH FOR DETERMINING THEORETICAL MINIMUM WEIGHT OF AIR REQUIRED FOR COMBUSTION OF A FUEL WHEN THE CHEMICAL ANALYSIS IS KNOWN

Method for the determination of the theoretical minimum weight of air required for combustion of a fuel when the chemical analysis is known. The chart also determines the theoretical maximum amount of carbon dioxide which would result if the fuel were completely burned with that amount of air. In addition, it is possible to determine the actual amount of air for lower values for the carbon dioxide content of the flue gases.

One of the two equations upon which the chart is based is that for the theoretical amount of air, where the weight of air in pounds per pound of dry fuel is

$$W_0 = 11.49C + 34.48(H - O/8) + 4.31S$$

where C is the carbon content, H is the hydrogen content, O is the oxygen content, and S is the sulphur content, all as decimal parts of the total dry weight. The carbon dioxide content of the flue gas = CO_2 = $2.4C/W$, as theoretical maximum.

Procedure. The use of the chart is in three stages, the first of which is to establish a straight line through the scale points corresponding to the known values for *Sulphur Content* and *Oxygen Content* on the scales so designated. The intersection of this line with the first blank axis, near the left-hand side of the chart, is then noted. A second straight line is then established through this point and the scale point corresponding to the known value of *Hydrogen Content* on *that* scale, and the intersection of this line is noted on the second blank axis, at the right side of the chart.

Then, a third straight line is set through this point and the scale point corresponding to the *Carbon Content,* and on the *A* scalings on the *Pounds Air per Pound Fuel* and *Carbon Dioxide—Per Cent* scales are read the final figures. To find the amount of air for an actual observed amount of carbon dioxide, a straight line through the scale points for the given values for *Carbon Content* and *Carbon Dioxide* will intersect the *Pounds Air per Pound Fuel* scale at a scale value that gives the answer. The *B* scales are added to increase the range of this operation.

To illustrate the use of the chart, conditions are determined for a bituminous coal of 0.777 carbon, 0.049 hydrogen, 0.108 oxygen, and 0.040 sulphur. First, a line is set through 4.0 per cent on the *Sulphur Content* scale and 10.8 on the *Oxygen Content* scale, and its intersection is noted on the blank axis at the left. A second line is then laid through this point and 4.9 on the *Hydrogen Content* scale, and its intersection is noted on the blank axis at the right. A third line through this point and 77.7 on the *Carbon Content* scale is then found to intersect the *Pounds Air per Pound Fuel A* scale at 10.32 and the *Carbon Dioxide—Per Cent* scale at 18.1. The computed values were 10.321 and 18.09, respectively.

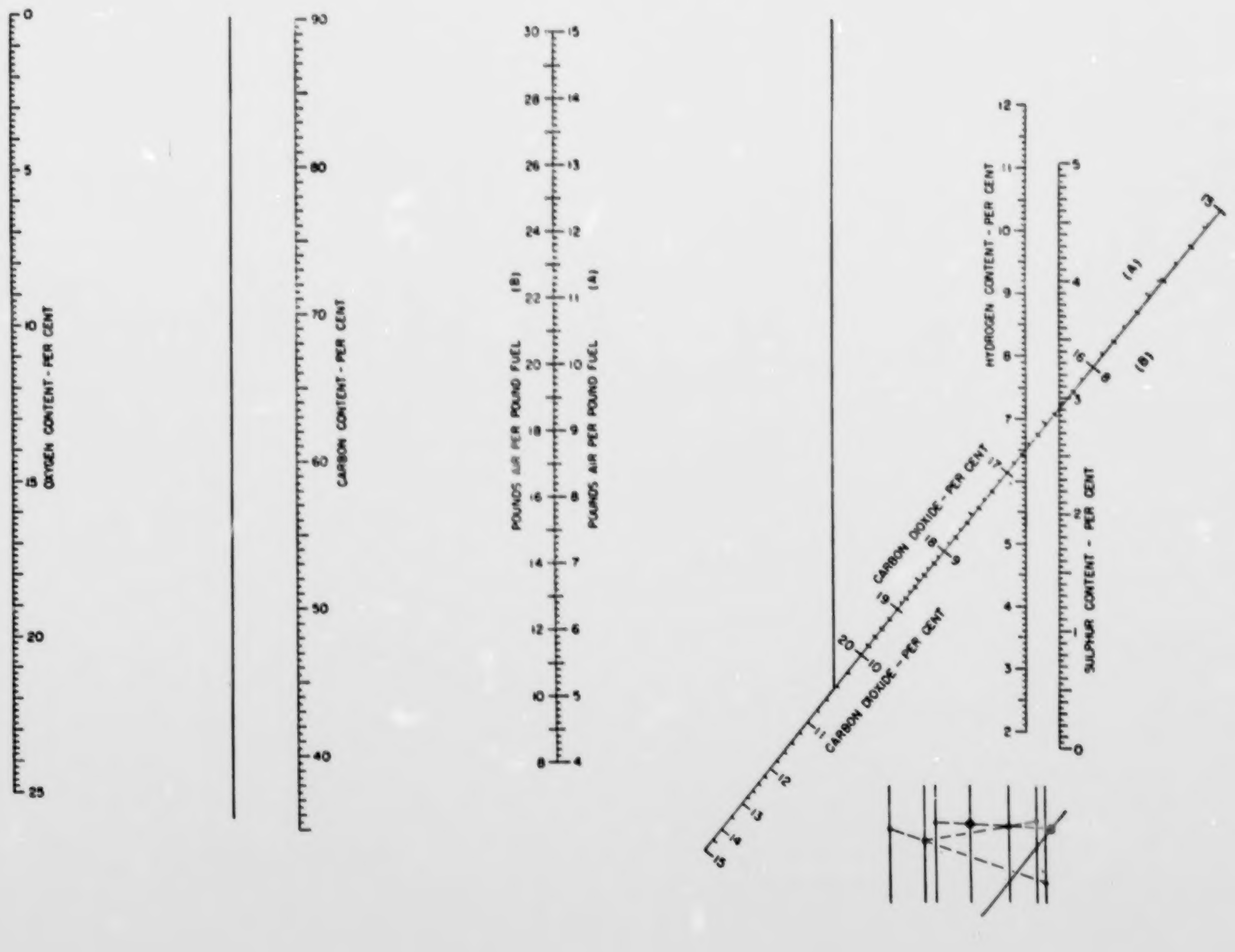
If the observed carbon dioxide in the stack gases is 12 per cent, a line is established through the scale point corresponding to this value (with use of the *B* scale necessary), and the scale point for 77.7 on the *Carbon Content* scale, and the amount of air per pound of fuel is read as 15.60, the computed value being 15.54.

To find the weight of the dry flue gases per pound of fuel, the weights of sulphur and carbon per pound of fuel are added, and eight times the weight of hydrogen is deducted.

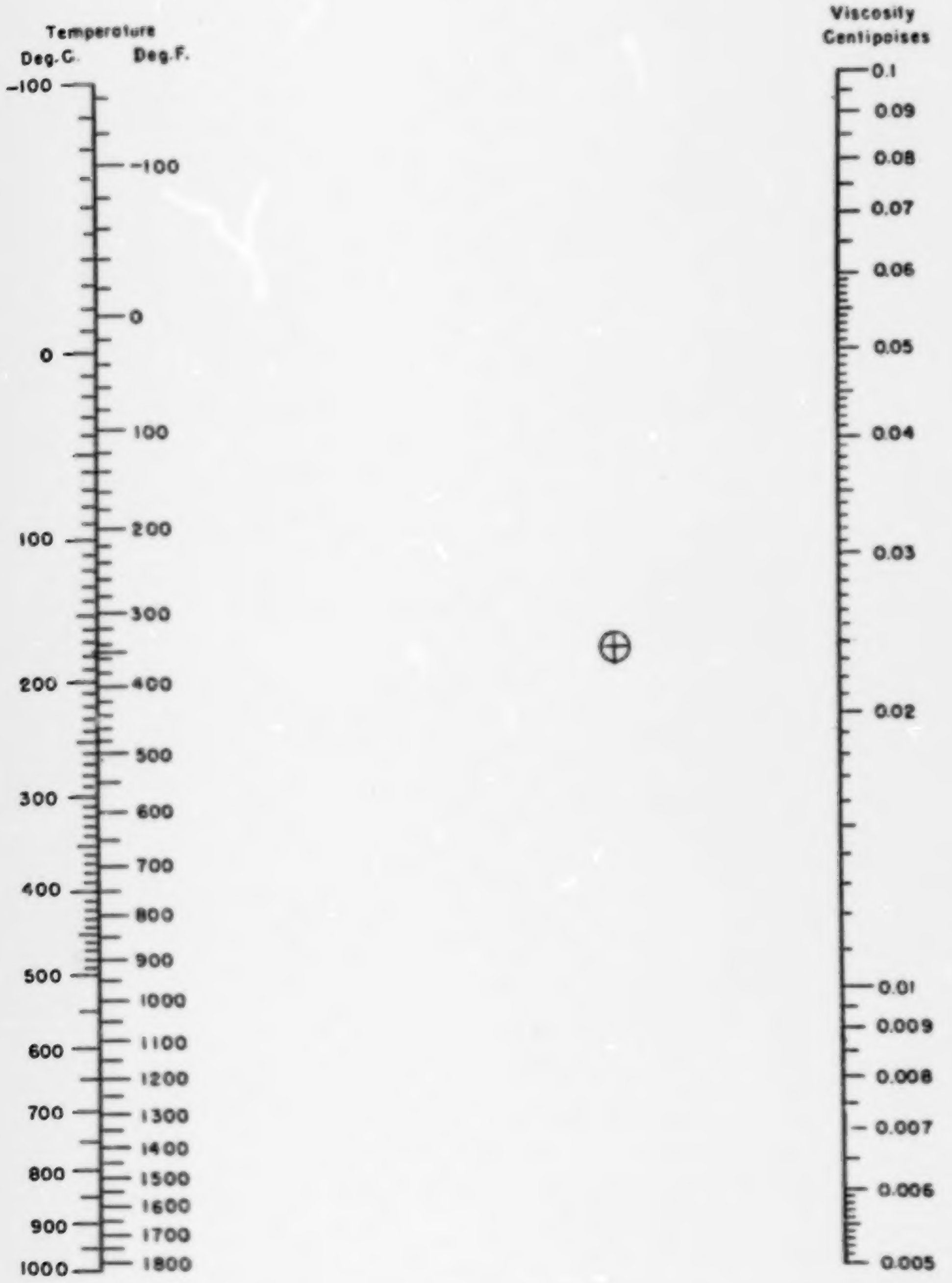
See Reference No. 11

NOMOGRAPH FOR DETERMINING THEORETICAL MINIMUM WEIGHT OF AIR REQUIRED FOR COMBUSTION OF A FUEL WHEN THE CHEMICAL ANALYSIS IS KNOWN

(continued)


OXYGEN CONTENT - PER CENT
0
5
10
15
20
25
CARBON CONTENT - PER CENT
90
80
70
60
50
40
POUNDS AIR PER POUND FUEL (B)
30
28
26
24
22
20
18
16
14
12
10
8
POUNDS AIR PER POUND FUEL (A)
15
14
13
12
11
10
9
8
7
6
5
4
CARBON DIOXIDE - PER CENT
CARBON DIOXIDE - PER CENT
(A)
(B)
HYDROGEN CONTENT - PER CENT
12
11
10
9
8
7
6
5
4
3
2
SULPHUR CONTENT - PER CENT
5
4
3
2
1
0

VISCOSITY OF AIR (CENTIPOISES) AT ONE ATMOSPHERE FOR VARIOUS TEMPERATURES °C AND °F



(1) centipoise	$(10)^{-2}\ \frac{gm}{cm-sec}$ $(10)^{-2}$ poise	$2.09(10)^{-5}\ \frac{\#_f - sec}{ft^2}$	$2.09(10)^{-5}\ \frac{slug}{ft - sec}$	$6.72(10)^{-4}\ \frac{\#_m}{ft - sec}$

See Reference No. 10

COMPOSITION OF DRY AIR
UP TO ABOUT 25 KILOMETERS

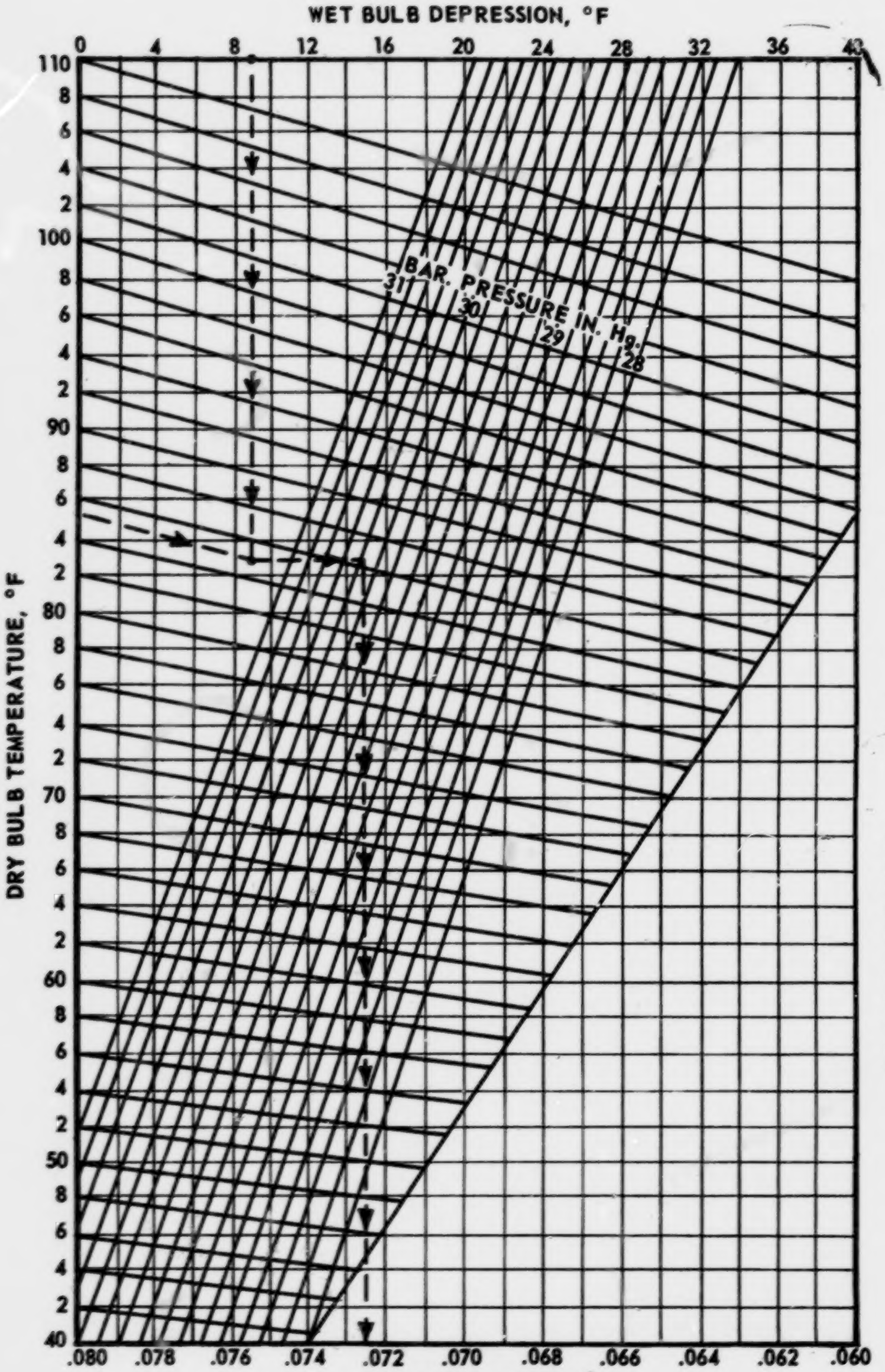
Constituent gas	Formula	Mol fraction %	Molecular weight
Nitrogen	N_2	78.09	28.016
Oxygen	O_2	20.95	32.000
Argon	Ar	.93	39.944
Carbon Dioxide *	CO_2	.03	44.010
Neon	Ne	1.8×10^{-3}	20.183
Helium	He	5.24×10^{-4}	4.003
Krypton	Kr	1.0×10^{-4}	83.7
Hydrogen	H_2	5.0×10^{-5}	2.0160
Xenon	Xe	8.0×10^{-6}	131.3
Ozone **	O_3	1.0×10^{-6}	48.000
Radon ***	Rn	6.0×10^{-18}	222

* Variable: see Carpenter, T.M., Journ. Amer. Chem. Soc., vol. 59, p. 358, 1937.
Haldane, J. B. S., Nature, vol. 1037, p. 575, 1936.
Callendar, G. S., Quart. Journ. Roy. Meteorol. Soc., vol. 66, p. 395, 1947.

** Variable: increasing with height.

*** Variable: decreasing with height.

AIR DENSITY CHART



EXAMPLE:

Dry bulb temperature = 85°F

Wet bulb temperature = 76°F

Barometric pressure = 30.2 in. Hg

SOLUTION:

At intersection of vertical line, giving wet bulb depression (9) with sloping dry bulb temperature line scale (85), draw horizontal line to inclined line denoting barometric pressure (30.2). From that intersection, vertical downward will give density of air (.0725 lb/sq. ft.^{3}).

See Reference No. 17

SECTION 14 PROPERTIES OF POTENTIAL POLLUTANTS

Selected Chemical and Physical Data on Potential Atmospheric Contaminants 14-1
Perceptible Concentrations and Characteristics of Various Substances in Air 14-17
Ring Structures of Polynuclear Organic Pollutants 14-20

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SELECTED CHEMICAL AND PHYSICAL DATA ON POTENTIAL ATMOSPHERIC CONTAMINANTS

ABBREVIATIONS USED

A., specific gravity with reference to air = 1
abs., absolute
al., alcohol
atm., atmosphere
°C., Centigrade degrees (All temperatures in Table I are in the Centigrade system.)
c., cold
ca., approximately
cc., cubic centimeters
$cm.^2$/sec., square centimeters per second
cryst., crystal
d., decomposes or decomposed
d.h., decomposes hot
dil., dilute
expl., explodes
h., hot
i., insoluble
ign., ignites
liq., liquid
m, meta position
mm., millimeters
n, normal
o, ortho position
p, para position
prim., primary
s., soluble
s. abs., soluble in absolute alcohol
s.h., soluble hot
sl. d., slightly decomposed
sl. s., slight or slightly soluble
subl., sublimes
v., very
v.s., very soluble
v.s.h., very soluble hot
v. sl., very slight or very slightly
v.sl.s., very slightly soluble
∞, soluble in all proportions
>, greater than
<, less than
±, about or near to, plus or minus
−0,800 loses an atom of oxygen at 800° C.
α, alpha form or position
β, beta form or position
ω, omega position

See Reference No. 5

SELECTED CHEMICAL AND PHYSICAL DATA ON POTENTIAL ATMOSPHERIC CONTAMINANTS

(continued)

Element, Compound or Other Substance	Chemical Formula	Specific Gravity or Density	Solubility in 100 Parts			Diffusion Coefficient in air (cm.²/sec.)	Melting Point, °C.	Boiling Point, °C.
			Water	Alcohol	Ether			
Acetaldehyde (ethanal)	$CH_3 \cdot CHO$	$0.783^{18°}_{4}$	∞	∞	∞		−123.5	20.2
Acetic acid (ethanoic acid)	$CH_3 \cdot COOH$	$1.049^{20°}_{4}$	∞	∞	∞	$0.1061^{0°}$ $0.1065^{0°}$ $0.1061^{0°}$	16.7	118.1
Acetic anhydride	$(CH_3CO)_2O$	$1.082^{20°}_{4}$	12c.; d.h.	∞	∞		−73	139.6
Acetone (propanone)	$CH_3 \cdot CO \cdot CH_3$	$0.792^{20°}_{4}$	∞	∞	∞		−94.6	56.5
Acetylene tetrachloride (sym-tetrachloroethane)	$Cl_2CH \cdot CHCl_2$	$1.600^{20°}_{4}$	i.	∞	∞		−36 (−43.8)	146.3
Acrolein (acrylic aldehyde)	$CH_2{:}CH \cdot CHO$	$0.841^{20°}_{4}$	40	s.	s.		−87.7	52.5
Acrylonitrile (vinyl cyanide)	$CH_2{:}CH \cdot CN$	$0.811^{20°}$	s.	..	..		−82	78-9
Allyl ether (diallyl ether)	$(CH{:}CH \cdot CH_2)_2O$	$0.826^{20°}_{4}$	0.3	∞	∞		...	94.3
Ammonia	NH_3	$0.817^{-79°}$	$89.9^{0°}$ $7.4^{96°}$	$14.8^{20°}$	s.		−77.7	−33.4
Amyl acetate (iso) (common amyl acetate)	$CH_3CO_2 \cdot (CH_2)_2 \cdot CH{:}(CH_3)_2$	$0.876^{15°}_{4}$	$0.25^{15°}$	∞	∞		...	$142^{737mm.}$
Amyl alcohol (prim. iso) (2-methyl-butanol-4)	$(CH_3)_2CH \cdot CH_2CH_2OH$	$0.813^{15°}_{4}$	$2^{14°}$	∞	∞	$0.0589^{0°}$ $0.0589^{0°}$	−117.2	132
n-Amyl butyrate	$C_2H_5CH_2CO_2(CH_2)_4 \cdot CH_3$	$0.871^{15°}_{4}$	$0.05^{20°}$	∞	∞		−73.2	186.4
n-Amyl formate	$HCO_2 \cdot C_5H_{11}$	$0.902^{0°}$	v.sl.s.	∞	∞		−73.5	132
n-Amyl nitrite	$C_5H_{11} \cdot O \cdot NO$	$0.853^{20°}$	sl.s.	∞	∞		...	104^{761mm}
Aniline (aminobenzene)	$C_6H_5 \cdot NH_2$	$1.022^{20°}_{4}$	$3.6^{18°}$	∞	∞		−6.2	184.4
Argon	A	$1.65^{-233°}$	5.6cc.$^{0°}$ 2.23cc.$^{50°}$	24cc.$^{15°}$	..		−189.2	−185.7
Arsenic (black)	As_4	$4.7^{20°}$	i.	..	..		...	...

SELECTED CHEMICAL AND PHYSICAL DATA ON POTENTIAL ATMOSPHERIC CONTAMINANTS
(continued)

Element, Compound or Other Substance	Chemical Formula	Specific Gravity or Density	Solubility in 100 Parts			Diffusion Coefficient in air (cm.²/sec.)	Melting Point, °C.	Boiling Point, °C.
			Water	Alcohol	Ether			
Arsenic trichloride (butter of arsenic)	$AsCl_3$	liq. 2.163	d.	. .	. .		−18	130
Arsine (arsenous hydride)	AsH_3	2.695(A)	20cc.	. .	. .		−113.5	−55;d.230
Barium peroxide	BaO_2	4.958	v.sl.s.	. .	. .		−0.800	. . .
Benzene (benzol)	C_6H_6	$0.879^{20^\circ}_{4}$	0.07^{22°	∞ abs. al.	∞	0.0751^{0°	5.4-5.5	80.1
Benzine (gasoline)	No definite composition	less than water	. .	. .	s.		. . .	. . .
Benzoyl chloride	$C_6H_5 \cdot CO \cdot Cl$	$1.212^{20^\circ}_{4}$	d.	d. h.	∞		−0.5	197.2
Benzyl amine (ω-aminotoluene)	$C_6H_5 \cdot CH_2 \cdot NH_2$	$0.982^{20^\circ}_{4}$	∞	∞	∞		. . .	184.5
Bromine	Br_2	$3.2^{0^\circ}_{4}$	3.13^{30°	s.	s.		−7.2	58.78
Bromobenzene (phenyl bromide)	C_6H_5Br	$1.495^{20^\circ}_{4}$	i.	s.	∞		−30.6	156.2
Bromoethane (ethyl bromide)	$C_2H_5 \cdot Br$	$1.460^{20^\circ}_{4}$	1.06^{0° 0.9^{30°	∞	∞		−118.9	38.4
Bromoethylene (vinyl bromide)	$CH_2{:}CH \cdot Br$	$1.529^{11^\circ}_{4}$	i.	∞	∞		−137.8	15.8
Bromomethane (methyl bromide)	$CH_3 \cdot Br$	$1.732^{0^\circ}_{0}$	v. sl. s.	s.	s.		−93	$4.5^{756mm.}$
Bromopropane (propyl bromide)	$CH_3 \cdot CH_2 \cdot CH_2 \cdot Br$	$1.353^{20^\circ}_{4}$	0.25^{20°	∞	∞	0.085	−109.9	70.8
Bromopropene (allyl bromide)	$CH_2{:}CH \cdot CH_2 \cdot Br$	$1.398^{20^\circ}_{4}$	i.	∞	∞		−119.4	$70\text{-}1^{753mm.}$
ω-Bromotoluene (benzyl bromide)	$C_6H_5 \cdot CH_2 \cdot Br$	1.443^{17°	i; sl. d.	∞	∞		−4	198-9
Bromoxylene (bromo-o-xylene[3])	$Br \cdot C_6H_3 \cdot (CH_3)_2$	$1.365^{20^\circ}_{4}$	i.	. .	. .		. . .	213-4

SELECTED CHEMICAL AND PHYSICAL DATA ON POTENTIAL ATMOSPHERIC CONTAMINANTS

(continued)

Element, Compound or Other Substance	Chemical Formula	Specific Gravity or Density	Solubility in 100 Parts			Diffusion Coefficient in air (cm.²/sec.)	Melting Point, °C.	Boiling Point, °C.
			Water	Alcohol	Ether			
1, 3-Butadiene (erythrene)	$CH_2{:}CH{\cdot}CH{:}CH_2$	$0.621^{20^\circ}_{4}$	i.	∞	∞		−108.9	−4.41
Butane (diethyl)	$CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}CH_3$	liq. 0.60^{0°	$15cc.^{17^\circ}_{772}$	$1883^{17^\circ}_{775}$	$2980^{18^\circ}_{773}$		−135	−0.6
n-Butanol	$C_2H_5{\cdot}CH_2{\cdot}CH_2OH$	$0.810^{20^\circ}_{4}$	9^{15°	∞	∞	0.0703 0.0681^{0°	−79.9	117
2-Butanone (methylethyl ketone)	$CH_3{\cdot}CO{\cdot}C_2H_5$	$0.805^{20^\circ}_{4}$	37	∞	∞		−85.9	79.6
Butene-1 (butylene)	$C_2H_5{\cdot}CH{:}CH_2$	liq. 0.6^{0°	i.	v. s.	v. s.		−130	$-5^{758mm.}$
n-Butyl acetate	$CH_3CO_2{\cdot}(CH_2)_3{\cdot}CH_3$	0.882^{20°	0.7	∞	∞	0.058	−76.3	$125.1^{740mm.}$
n-Butyl cellosolve	$C_4H_9{\cdot}O{\cdot}CH_2CH_2OH$	$0.903^{20^\circ}_{4}$	∞	∞	∞		. . .	171.2
n-Butyl formate	$HCO_2{\cdot}(CH_2)_3{\cdot}CH_3$	0.911^{0°	v.sl.s.	∞	∞		. . .	106.9
Butyl ether (n-dibutyl ether)	$(C_2H_5{\cdot}CH_2{\cdot}CH_2)_2O$	$0.769^{20^\circ}_{20^\circ}$	<0.05	∞	∞		−98	142.4
n-Butyl nitrite	$C_4H_9{\cdot}O{\cdot}NO$	0.911^{0°	. .	∞	∞		. . .	77-9
Cacodyl oxide (cacodylic oxide)	$[(CH_3)_2As]_2O$	1.486^{15°	sl.s.	s.	s.		−57	150
Cadmium	Cd	8.65^{20°	i.	. .	. .		320.9	767
Carbon dioxide	CO_2	solid 1.56^{-79°	$179.7cc.^{0^\circ}$ $90.1cc.^{20^\circ}$	. .	. .	0.138	$-56.5^{5.2\,atm.}$	subl. −78.5
Carbon disulfide	CS_2	liq. $1.261^{22^\circ}_{20}$	0.2^{0° 0.014^{50°	∞	∞	0.0892 0.0883^{0° 0.0883^{0°	−108.6	46.3
Carbon monoxide	CO	liq. $0.814\frac{-195^\circ}{4}$	0.0044^{0° 0.0018^{50°	s.	. .		−207	−192
Carbon tetrachloride	CCl_4	$1.595^{20^\circ}_{4}$	0.097^{0° 0.08^{20°	∞	∞		−22.6	76.8
Carrene No. 2	(See monofluorotrichloromethane)							

SELECTED CHEMICAL AND PHYSICAL DATA ON POTENTIAL ATMOSPHERIC CONTAMINANTS

(continued)

Element, Compound or Other Substance	Chemical Formula	Specific Gravity or Density	Solubility in 100 Parts			Diffusion Coefficient in air (cm.²/sec.)	Melting Point, °C.	Boiling Point, °C.
			Water	Alcohol	Ether			
Cellosolve (2-ethoxy-ethanol-1)	$C_2H_5 \cdot O \cdot (CH_2)_2OH$	$0.931^{20°}_{4}$	∞	∞	∞		−70	135.1
Cellosolve acetate	$CH_3CO_2C_4H_9O$	$0.975^{20°}_{4}$	22	∞	∞		−61.7	156.3
Chlorine	Cl_2	liq. $1.56^{-33.6°}$	$1.46^{0°}$g. $310cc.^{10°}$	. .	. .		−101.6	−34.6
Chlorine dioxide (chlorine peroxide)	ClO_2	$2.4^{11°}$ (A)	$2000cc.^{4°}$	expl.	expl.		−76	$9.9^{731mm.}$ expl. 100
Chlorine monoxide	Cl_2O	2.9(A)	$20,000cc.^{0°}$	expl.	expl.		−20	$3.8^{737mm.}$ expl.
Chloroacetone	$Cl \cdot CH_2 \cdot CO \cdot CH_3$	$1.162^{16°}$	∞	∞	∞		−44.5	121
Chlorobenzene (phenyl chloride)	$C_6H_5 \cdot Cl$	$1.107^{20°}_{4}$	i.	∞	∞		−45.2	132.1
2-Chlorobutadiene (chloroprene)	$CH_2{:}CCl \cdot CH{:}CH_2$	$0.958^{20°}_{20}$	sl.s.	∞	∞		. . .	59.4
o-Chlorodiphenyl (chlorobiphenyl)	$Cl \cdot C_6H_4 \cdot C_6H_5$	. .	i.	. .	. .		34	267-8
Chloroform (trichloromethane)	$CHCl_3$	$1.489^{20°}$	$0.82^{20°}$	∞	∞		−63.5	61.2
Chloronaphthalenes (See Penta and trichloronaphthalenes)								
1-Chloro-1-nitropropane	$C_2H_5 \cdot CH(Cl)NO_2$	$1.209^{20°}_{20°}$	$<0.8^{20°}$	. .	. .		. . .	140-3
Chloropropane (n-propyl chloride)	$CH_3 \cdot CH_2 \cdot CH_2Cl$	$0.890^{20°}_{4}$	$0.27^{20°}$	∞	∞		−122.8	46.4
3-Chloropropene-1 (allyl chloride)	$CH_2{:}CH \cdot CH_2Cl$	$0.938^{20°}_{4}$	<0.1	∞	∞		−136.4	44.6
Chloropicrin (nitrochloroform)	$NO_2 \cdot CCl_3$	$1.651^{22.8°}_{4}$	$0.17^{18°}$	37cc. 80% al.	s.		−64	$112.3^{766mm.}$
ω-Chlorotoluene (benzyl chloride)	$C_6H_5 \cdot CH_2 \cdot Cl$	$1.100^{20°}_{20}$	i.	∞	∞	0.066	−39	179.4
Chlorovinyldichloroarsine (Lewisite)	$ClCH{:}CH \cdot AsCl_2$	$1.888^{20°}_{4}$	i.	. .	. .		. . .	190

SELECTED CHEMICAL AND PHYSICAL DATA ON POTENTIAL ATMOSPHERIC CONTAMINANTS

(continued)

Element, Compound or Other Substance	Chemical Formula	Specific Gravity or Density	Solubility in 100 Parts			Diffusion Coefficient in air (cm.²/sec.)	Melting Point, °C.	Boiling Point, °C.
			Water	Alcohol	Ether			
Chloroxylene (o-xylylchloride)	$Cl \cdot C_6H_3(CH_3)_2$	..	i.	∞	∞		< −20	189.5
Chromic acid (chromium trioxide)	CrO_3	2.70	$164.9^{0°}$	s.	s.		197 d.	...
o-Cresol	$CH_3 \cdot C_6H_4 \cdot OH$	$1.048^{20°}_{4}$	2.5	$\infty^{30°}$	$\infty^{31°}$		30.8	190.8
m-Cresol	$CH_3 \cdot C_6H_4 \cdot OH$	$1.034^{20°}_{4}$	0.5	∞	∞		10.9	202.8
p-Cresol	$CH_3 \cdot C_6H_4 \cdot OH$	$1.035^{20°}_{4}$	1.8	$\infty^{36°}$	$\infty^{36°}$		35-6	202
Cyanogen	C_2N_2	liq. $0.866^{-17.2°}$	450cc.$^{20°}$	2300cc.$^{20°}$	500cc.$^{18°}$		−34.4	−20.5
Cyanogen bromide	$Br \cdot CN$	$2.015^{20°}$	s.	s.	s.		52	$61.3^{750mm.}$
Cyanogen chloride	$Cl \cdot CN$	$1.222^{0°}$	2500cc.$^{20°}$	10,000cc.$^{20°}$	5000cc.$^{20°}$		−6.5	12.5-13
Cyclohexane (benzene hexahydride)	$CH_2 \cdot (CH_2)_4 \cdot CH_2$	$0.779^{20°}_{4}$	i.	∞	∞		6.5	80-1
Cyclohexanol (hexahydrophenol)	$CH_2 \cdot (CH_2)_4 \cdot CHOH$	$0.962^{20°}_{4}$	$3.6^{20°}$	s.	s.		23.9	160-1
Cyclohexanone (pimelin ketone)	$CH_2 \cdot (CH_2)_4 \cdot CO$	$0.947^{19°}_{4}$	s.	s.	s.		−45	155-6
Cyclohexene (benzene tetrahydride)	$CH_2(CH_2)_3 \cdot CH{:}CH$	$0.810^{20°}_{4}$	v.sl.s.	v.s.	v.s.		−103.7	83.3
n-Decane	$CH_3 \cdot (CH_2)_8 \cdot CH_3$	$0.730^{20°}$	i.	∞	∞		−29.7	174.0
1, 2-Dibromoethane (ethylene bromide)	$BrCH_2 \cdot CH_2Br$	$2.180^{20°}_{4}$	v.sl.s.	∞	∞		10	131.5
o-Dichlorobenzene	$C_6H_4Cl_2$	$1.305^{20°}_{4}$	i.	∞	∞		−17.6	179
Dichlorodifluoromethane (Freon-12)	CCl_2F_2	$1.486^{-30°}$	i.	s.	s.		−160	−28
1, 1-Dichloroethane (ethylene dichloride)	$CH_3 \cdot CHCl_2$	$1.175^{20°}_{4}$	$0.5^{30°}$	∞	∞		−96.7	57.3
1, 2-Dichloroethane (ethylene chloride)	$ClCH_2 \cdot CH_2Cl$	$1.256^{20°}_{20}$	$0.9^{30°}$	∞	∞		−35.3	83.7
1, 2-Dichloroethylene (1, 2-dichloroethene)	$CHCl{:}CHCl$	$1.291^{15°}_{4}$	$0.35^{20°}$	∞	∞		−80.5	60.3
Dichloroethyl ether (β, β_1-dichloro ether)	$(ClCH_2 \cdot CH_2)_2O$	$1.222^{20°}_{20}$	$1.07^{20°}$	s.	s.		...	178.5

SELECTED CHEMICAL AND PHYSICAL DATA ON POTENTIAL ATMOSPHERIC CONTAMINANTS

(continued)

Element, Compound or Other Substance	Chemical Formula	Specific Gravity or Density	Solubility in 100 Parts			Diffusion Coefficient in air (cm.²/sec.)	Melting Point, °C.	Boiling Point, °C.
			Water	Alcohol	Ether			
Dichlorodiethyl sulfide (mustard gas)	$(Cl\cdot CH_2\cdot CH_2)_2S$	$1.275^{20^\circ}_{4}$	0.07^{25°	s.	s.		13-4	217 sl.d.
Dichloromethane (methylene chloride)	$CH_2{:}Cl_2$	$1.336^{20^\circ}_{4}$	2^{20°	∞	∞		−96.7	40-1
Dichloromethyl ether	$ClCH_2\cdot O\cdot CH_2Cl$	$1.328^{15^\circ}_{4}$	d.	. .	. .		. . .	104-5
Dichloromonofluoromethane (Freon-21)	$CHCl_2F$	1.421^{0°	i.	s.	s.		−127	8.9
1, 1-Dichloro-1-nitroethane	$Cl_2C(NO_2)\cdot CH_3$	$1.405^{20^\circ}_{20}$	$<0.5^{20^\circ}$	. .	. .		. . .	122-5
1, 2-Dichloropropane (propylene chloride)	$CH_3\cdot CHCl\cdot CH_2Cl$	$1.159^{20^\circ}_{20}$	0.27^{20°	v.s.	v.s.		<-70	96.8
Difluoromonochloroethane (Freon-114)								
Diethyl amine	$(C_2H_5)_2NH$	$0.712^{15^\circ}_{15}$	v.s.	∞	∞		−38.9	$55.5^{759mm.}$
Diethyl sulfate (ethyl sulfate)	$(C_2H_5O)_2SO_2$	$1.172^{25^\circ}_{4}$	i.,sl.d.	s.	∞		−25	210.2 sl.d.
Diethylene glycol (glycol ether)	$(HO\cdot CH_2\cdot CH_2)_2O$	$1.118^{20^\circ}_{20}$	∞	∞	i.		. . .	244.8
Diethylene glycol monoethyl ether (carbitol)	$HO\cdot(CH_2)_2\cdot O(CH_2)_2\cdot O\cdot C_2H_5$	$0.990^{20^\circ}_{20}$	∞	v.s.	s.		. . .	201.9
Difluoromonochloromethane (Freon-22)	$CHClF_2$	3.87^{0°	i.	. .	. .		−146	−40.8
Dimethyl amine	$(CH_3)_2NH$	$0.680^{0^\circ}_{4}$	v.s.	s.	s.		−96	7.4
Dimethyl aniline	$(CH_3)_2N\cdot C_6H_5$	$0.956^{20^\circ}_{4}$	i.	s.	s.		2.5	193
Dimethyl arsine (cacodyl hydride)	$(CH_3)_2AsH$	1.213^{29°	. .	∞	∞		. . .	$35.6^{747mm.}$
Dimethyl mercury (mercury dimethyl)	$(CH_3)_2Hg$	$2.954^{22^\circ}_{4}$	v.sl.s.	v.s.	v.s.		. . .	95-6
Dimethyl sulfate (methyl sulfate)	$(CH_3O)_2SO_2$	$1.352^{0^\circ}_{4}$	v.sl.s.	∞	∞		−26.8	188.3-8.6

SELECTED CHEMICAL AND PHYSICAL DATA ON POTENTIAL ATMOSPHERIC CONTAMINANTS

(continued)

Element, Compound or Other Substance	Chemical Formula	Specific Gravity or Density	Solubility in 100 Parts			Diffusion Coefficient in air (cm.²/sec.)	Melting Point, °C.	Boiling Point, °C.
			Water	Alcohol	Ether			
Dinitrotoluene (3, 5)	$(NO_2)_2C_6H_3\cdot CH_3$	$1.277^{111°}$	sl.s.	s.h.	s.		92-3	subl.
Dioxane (1, 4) (diethylene oxide)	$O:(CH_2)_4:O$	$1.072^{20°}_{20}$	∞	. .	. .		. . .	226
Diphosgene (trichloromethyl chloroformate)	$Cl\cdot CO_2\cdot CCl_3$	$1.653^{14°}$	d.?	. .	. .		−57	127.5
Ethane	$CH_3\cdot CH_3$	$0.546^{-88°}$	$4.7cc.^{20°}$	abs.,150cc.	. .		−172	−88.6
Ethene (ethylene)	$CH_2:CH_2$	0.975(A)	$25.6cc.^{0°}$	360cc.	s.		−169	−103.9
Ethyl acetate (acetic ether)	$CH_3CO_2\cdot C_2H_5$	$0.901^{20°}_{4}$	$8.5^{15°}$	∞	∞	0.0715 0.0709 0.0709	−82.4	77.1
Ethyl alcohol (ethanol)	$CH_3\cdot CH_2OH$	$0.789^{20°}_{4}$	∞	. .	∞	0.102 0.1016 0.0994	−112	78.4
Ethyl amine (aminoethane)	$C_2H_5\cdot NH_2$	$0.689^{15°}_{15}$	∞	∞	∞		−80.6	16.6
Ethyl benzene (phenyl ethane)	$C_6H_5\cdot C_2H_5$	$0.867^{20°}_{4}$	$0.01^{15°}$	∞	∞	0.0658	−94.4	136.2
Ethyl bromide (bromoethane)	$C_2H_5\cdot Br$	$1.431^{20°}_{4}$	$0.9^{20°}$	∞	∞		−117.8	38.4
n-Ethyl butyrate	$C_2H_5\cdot CH_2\cdot CO_2\cdot C_2H_5$	$0.879^{20°}_{4}$	$0.68^{25°}$	∞	∞	0.0579 $0.0574^{0°}$ $0.0574^{0°}$	−93.3	120-1
Ethyl chloride (chloroethane)	$C_2H_5\cdot Cl$	$0.917^{6°}_{6}$	0.45 $0.57^{20°}$	∞	∞		−139	13 12.2
Ethyl chloroacetate	$Cl\cdot CH_2\cdot CO_2\cdot C_2H_5$	$1.159^{20°}_{4}$	i.	∞	∞		−26	144
Ethyl dichlorarsine	$C_2H_5\cdot AsCl_2$	$1.742^{15°}_{4}$	sl.s.	∞	∞		. . .	156
Ethylene chlorohydrin (2-chloro-ethanol-1)	$ClCH_2\cdot CH_2OH$	$1.213^{20°}_{4}$	∞	∞	∞		−69	128.8

SELECTED CHEMICAL AND PHYSICAL DATA ON POTENTIAL ATMOSPHERIC CONTAMINANTS

(continued)

Element, Compound or Other Substance	Chemical Formula	Specific Gravity or Density	Solubility in 100 Parts			Diffusion Coefficient in air (cm.²/sec.)	Melting Point, °C.	Boiling Point, °C.
			Water	Alcohol	Ether			
Ethylene dichloride	(See dichloroethane)							
Ethylene glycol (glycol)	$HOCH_2 \cdot CH_2OH$	$1.113^{19°}_{4}$	∞	∞	1.0		−15.6	197.4
Ethylene glycol-mono-methyl ether (methyl cellosolve)	$CH_3O(CH_2)_2OH$	$0.956^{20°}_{4}$	∞	∞	∞		. . .	124-5
Ethylene oxide	$CH_2 \cdot CH_2 \cdot O$	$0.887^{7°}_{4}$	∞	∞	v.s.		−111.3	$13.5^{747mm.}$
Ethyl ether (ether)	$(C_2H_5)_2O$	$0.708^{25°}_{4}$	$7.5^{20°}$	∞	. .	0.0778 $0.08270^{0°}$ $0.0775^{0°}$	α −116.3 β −123.3	34.6
Ethyl formate	$HCOO \cdot C_2H_5$	$0.923^{20°}_{4}$	$11^{18°}$	∞	∞	0.0840 $0.0852^{0°}$	−79	$54^{760mm.}$
Ethyl nitrate (nitric ether)	$C_2H_5 \cdot O \cdot NO_2$	$1.100^{25°}_{4}$	$1.3^{55°}$	∞	∞		−102	87-8
Ethyl nitrite	$C_2H_5 \cdot O \cdot NO$	$0.900^{15.5°}$	v.sl.s.	∞	∞		. . .	17
Ethyl silicate	$Si(OC_2H_5)_4$	$0.936^{20°}_{20}$	sl.d.	∞	. .		. . .	168.1
Ethyne (acetylene)	$CH \vdots CH$	0.906(A)	$100cc.^{18°}$	$600cc.^{18°}$	. .		$-81.5^{891mm.}$	$-84^{760mm.}$
Fluorine	F_2	$1.31(A)^{15°}$	d.	. .	. .		−223	−187
Fluoride dusts, smokes								
Formaldehyde (methanal)	$H \cdot CH{:}O$	$0.815^{-20°}$	v.s.	v.s.	v.s.		−92±	−21
Freon	(see dichlorodifluoromethane)							
Furfural (2) (furfurol)	$C_4H_3O \cdot CHO$	$1.159^{20°}_{4}$	$9.1^{13°}$	∞	∞		−38.7	$161.7^{760mm.}$
Gasoline								
Helium	He	0.1368(A)	$0.97cc.^{0°}$	. .	. .		< −272.2	−268.9
n-Heptane	$CH_3 \cdot (CH_2)_5 \cdot CH_3$	$0.684^{20°}_{4}$	i.	sl.s.	∞		−90.6	$98.4^{760mm.}$
Heptene (α) (heptene-1)	$CH_3 \cdot (CH_2)_4 \cdot CH{:}CH_2$	$0.703^{19°}$	i.	s.	s.		. . .	95-100

SELECTED CHEMICAL AND PHYSICAL DATA ON POTENTIAL ATMOSPHERIC CONTAMINANTS

(continued)

Element, Compound or Other Substance	Chemical Formula	Specific Gravity or Density	Solubility in 100 Parts			Diffusion Coefficient in air (cm.²/sec.)	Melting Point, °C.	Boiling Point, °C.
			Water	Alcohol	Ether			
n-Hexane	$CH_3\cdot(CH_2)_4\cdot CH_3$	$0.659^{20°}_{4}$	i.	$50^{33°}$	∞		−94	69
Hexanone-3 (ethyl n-propyl ketone)	$C_2H_5\cdot CO\cdot CH_2\cdot C_2H_5$	$0.813^{21.8°}_{4}$	v.sl.s.	∞	∞		...	123-4
Hexene (α) (1-hexene)	$CH_3\cdot(CH_2)_3\cdot CH{:}CH_2$	$0.673^{20°}_{4}$	i.	∞	∞		−98.5	63.4-3.7
Hexone (methyl isobutyl ketone)	$CH_3\cdot CO\cdot C_4H_9$	$0.830^{0°}$	v.sl.s.	∞	∞		−56.9	$127.5^{755mm.}$
Hydrochloric acid (hydrogen chloride)	HCl	$1.268(A)^{0°}$	$82.3^{0°}$	s.	s.		−111	−85
Hydrogen	H_2	0.06948(A)	$2.1cc.^{0°}$ $0.85cc.^{80°}$	..	..		−259.1	−252.7
Hydrogen antimoniate	SbH_3 (See Stibine)							
Hydrogen cyanide (prussic acid)	HCN	$0.697^{18°}$	∞	∞	∞		−14	26
Hydrogen fluoride	HF	$0.988^{13.6°}$	v.s.	..	..		−83	19.4
Hydrogen selenide	H_2Se	$2.12^{-42°}$	$270cc.^{22.5°}$	..	..		−64	−42
Hydrogen sulfide	H_2S	1.1895(A)	$437cc.^{0°}$ $186cc.^{40°}$	$9.54cc.^{15°}$	..		−82.9	−59.6
Iodine	I_2	$4.93^{20°}$	$0.0162^{0°}$ $0.0957^{60°}$	s.	s.	0.097	113.5	184.35
Iodoethane (ethyl iodide)	$CH_3\cdot CH_2\cdot I$	$1.933^{20°}_{4}$	$0.4^{20°}$	∞	∞		−105	72.4
Iodoethene (vinyl iodide)	$CH_2{:}CH\cdot I$	$2.08^{0°}$	..	..	..		...	56
Iodomethane (methyl iodide)	$CH_3\cdot I$	$2.279^{20°}_{4}$	$1.8^{15°}$	∞	∞		−64.4	42.4
Iodopropene (allyl iodide)	$CH_2{:}CH\cdot CH_2I$	$1.848^{12°}_{12}$	i.	∞	∞		−99.3	$102^{744mm.}$
Iron oxide (ferric oxide) (hematite)	Fe_2O_3	5.12	i.	..	..		1560d.	

SELECTED CHEMICAL AND PHYSICAL DATA ON POTENTIAL ATMOSPHERIC CONTAMINANTS

(continued)

Element, Compound or Other Substance	Chemical Formula	Specific Gravity or Density	Solubility in 100 Parts			Diffusion Coefficient in air (cm.²/sec.)	Melting Point, °C.	Boiling Point, °C.
			Water	Alcohol	Ether			
Isophorone	$C_9H_{14}O$	$0.9227^{18°}_{20}$	. .	. .	. .		. . .	205-220
Lead	Pb	$11.337^{20°}_{20}$	i.	. .	. .		327.5	1620
Magnesium	Mg	$1.74^{20°}$	i.	. .	. .		651	1110
Manganese	Mn	$7.2^{20°}$	d.	. .	. .		1260	1900
Mercury	Hg	$13.546^{20°}$	i.	. .	. .		−38.87	356.9
Mesityl oxide	$(CH_3)_2C{:}CH{\cdot}CO{\cdot}CH_3$	$0.858^{20°}_{4}$	$3^{20°}$	∞	∞		−59	$129\text{-}30^{750mm.}$
Methane (marsh gas)	CH_4	$0.554^{0°}_{760}$(A)	$0.35cc.^{20°}$	$47.1cc.^{20°}$	$104cc.^{16°}$		−182.6	−161.4
Methanol (methyl alcohol) (wood alcohol)	$CH_3{\cdot}OH$	$0.792^{20°}_{4}$	∞	∞	∞	0.1325 $0.1325^{0°}$ $0.1325^{0°}$	−97.8	64.7
Methylacetate	$CH_3{\cdot}CO_2{\cdot}CH_3$	$0.924^{20°}_{4}$	$33^{22°}$	∞	∞	0.084 $0.084^{0°}$ $0.084^{0°}$	−98.7	57.1
Methyl amine (aminomethane)	$CH_3{\cdot}NH_2$	$0.699^{-11°}$	$959cc.^{25°}$	s.	. .		−92.5	$-6.7^{758mm.}$
Methyl arsine	$CH_3{\cdot}AsH_2$	. .	0.01	∞	∞		. . .	2
Methyl bromide (bromomethane)	$CH_3{\cdot}Br$	$1.732^{0°}_{0}$	v.sl.s.	s.	s.		−93	$4.5^{758mm.}$
Methyl butyrate	$C_2H_5{\cdot}CH_2{\cdot}CO_2{\cdot}CH_3$	$0.898^{20°}_{4}$	1.7	∞	∞	0.0633 $0.0641^{0°}$ $0.0641^{0°}$	< −95	102.3
Methyl cellosolve (2-methoxy-ethanol)	$CH_3O(CH_2)_2OH$	$0.965^{20°}_{4}$	∞	∞	∞		. . .	124-5
Methyl cellosolve acetate	$CH_3{\cdot}CO_2{\cdot}CH_2{\cdot}CH_2OCH_3$	$1.007^{20°}_{20}$	∞	. .	. .		solid −70	144.5
Methyl chloride (chloromethane)	CH_3Cl	1.785(A)	$280cc.^{16°}$	$3500cc.^{20°}$	s.		−97.7	−24
Methyl chloroformate	$Cl{\cdot}CO_2{\cdot}CH_3$	$1.236^{15°}$	d.	∞	∞		. . .	71-2

SELECTED CHEMICAL AND PHYSICAL DATA ON POTENTIAL ATMOSPHERIC CONTAMINANTS

(continued)

Element, Compound or Other Substance	Chemical Formula	Specific Gravity or Density	Solubility in 100 Parts			Diffusion Coefficient in air (cm.²/sec.)	Melting Point, °C.	Boiling Point, °C.
			Water	Alcohol	Ether			
Methyl cyclohexane (toluene hexahydride)	$CH_3(CHC_5H_{10})$	$0.769^{20°}_{4}$	i.	s.	s.		−126.3	101
o-Methyl cyclohexanol (cis) (hexahydro-o-cresol)	$CH_3 \cdot C_6H_{10} \cdot OH$	$0.934^{20°}_{4}$	v.sl.s.	∞	∞		−9.5	165
o-Methyl cyclohexanone	$CH_3 \cdot C_6H_9{:}O$	$0.925^{18°}_{4}$	i.	s.	s.		. . .	162-5
Methyl dichlorarsine	$CH_3 \cdot AsCl_2$	$1.838^{20°}_{4}$	sl.s.	. .	. .		−59	133-6
Methyl ethyl ketone (butanone)	$CH_3 \cdot CO \cdot C_2H_5$	$0.805^{20°}_{4}$	37	∞	∞		−85.9	79.6
Methyl formate	$HCO_2 \cdot CH_3$	$0.974^{20°}_{4}$	$30^{23°}$	∞	. .		−99.8	32
Methyl isobutyl ketone	$CH_3 \cdot CO \cdot C_4H_9$	$0.801^{20°}_{4}$	$2^{20°}$	∞	∞		−84.7	117-9
Methyl nitrate	$CH_3O \cdot NO_2$	$1.203^{25°}$	. .	s.	s.		expl.	65
Methyl nitrite	$CH_3O \cdot NO$	liq. $0.991^{17°}$	. .	s.	s.		. . .	−12
Methyl propyl ketone (pentone-2) (pentanone-2)	$CH_3 \cdot CO \cdot CH_2 \cdot C_2H_5$	$0.812^{15°}_{15}$	v.sl.s.	∞	∞		−77.8	102
Monochlorobenzene (phenyl chloride)	$C_6H_5 \cdot Cl$	$1.107^{20°}_{4}$	i.	∞	∞		−45.2	132.1
Monofluorotrichloromethane (Freon-11-Carrene #2)	Cl_3CF	$1.494^{17.2°}$	i.	∞	∞		−111	24.1
o-Mononitro-toluene	$CH_3 \cdot C_6H_4 \cdot NO_2$	$1.163^{20°}_{4}$	v.sl.s.	∞	∞		α −10.6 β − 4.1	222.3
Naptha (coal tar)	Consists largely of xylenes and higher homologues.						. . .	ca. 160
Naphtha (petroleum)	Mixture of hydrocarbons	0.73-0.75	i.	s.	s.		. . .	80-130
Neon	Ne	0.674(A)	$2.6cc.^{0°}$	s.	. .		−248.67	−245.9
Nickle carbonyl	$Ni(CO)_4$	$1.31^{17°}$	$0.18^{9.8°}$	s.	s.		−25	$43^{751mm.}$
Nitric oxide	NO or $(NO)_2$	1.0367(A)	$7.34cc.^{0°}$	26.6cc.	. .		−161	−151
Nitrobenzene (oil of mirbane)	$C_6H_5 \cdot NO_2$	$1.205^{18°}_{4}$	0.2	v.s.	∞		5.6-5.7	210.9

SELECTED CHEMICAL AND PHYSICAL DATA ON POTENTIAL ATMOSPHERIC CONTAMINANTS

(continued)

Element, Compound or Other Substance	Chemical Formula	Specific Gravity or Density	Solubility in 100 Parts			Diffusion Coefficient in air (cm.²/sec.)	Melting Point, °C.	Boiling Point, °C.
			Water	Alcohol	Ether			
Nitroethane	$CH_3 \cdot CH_2 \cdot NO_2$	$1.052^{20^\circ}_{20}$	4.5^{20°	∞	∞		−90	$114.8^{761mm.}$
Nitrogen dioxide	NO_2 or $(NO_2)_2$	1.448^{20°	d.	. .	. .		−9.3	21.3
Nitrous oxide	N_2O	1.530(A)	$130.52cc.^{0^\circ}$	s.	. .		−102.3	−90.7
Nitroglycerine	$(O_2N \cdot O)_3C_3H_5$	1.601^{15°	0.18^{20°	54^{21° abs.	∞		13.3(2.0)	$160^{15mm.}$ expl. 270
Nitromethane	$CH_3 \cdot NO_2$	$1.138^{20^\circ}_{20}$	9.5^{20°	s.	s.		−28.5	$101.5^{765mm.}$
2-Nitropropane (β-nitropropane)	$(CH_3)_2 \cdot CH \cdot NO_2$	1.024^{0°	1.7^{20°	∞^{20°	∞^{20°		−93	120.3
n-Nonane	$CH_3 \cdot (CH_2)_7 \cdot CH_3$	$0.718^{20^\circ}_{4}$	i.	s.abs.	s.		−53.7	$150.5^{759mm.}$
n-Octane	$CH_3 \cdot (CH_2)_6 \cdot CH_3$	$0.703^{20^\circ}_{4}$	i.	sl.s.	s.		−56.5	125.7
Oxygen	O_2	1.1053(A)	$4.89cc.^{0^\circ}$	. .	. .		−218.4	−183
Ozone	O_3	1.658(A)	$0.494cc.^{0^\circ}$	. .	. .		−251	−112
Pentachloroethane (pentalin)	$CHCl_2 \cdot CCl_3$	$1.671^{25^\circ}_{4}$	0.05^{21°	∞	∞		−22	162
Pentachloronaphthalene								
n-Pentane	$(C_2H_5)_2CH_2$	$0.630^{18^\circ}_{4}$	i.	∞	∞		−129.7	36.3
n-Pentanol (amyl alcohol)	$CH_3 \cdot (CH_2)_3 \cdot CH_2OH$	$0.817^{20^\circ}_{20}$	2.7^{22°	∞	∞		. . .	137.8-7.9
2-Pentanone (methyl propyl ketone)	$CH_3 \cdot CO \cdot CH_2 \cdot C_2H_5$	$0.812^{15^\circ}_{15}$	v.sl.s.	∞	∞		−77.8	102
Perchloroethylene (ethylene tetrachloride)	$Cl_2C:CCl_2$	$1.624^{15^\circ}_{4}$	i.	∞	∞		−19	120.8
Phenol (carbolic acid)	$C_6H_5 \cdot OH$	$1.071^{25^\circ}_{4}$	8.2^{15°; $\infty^{65.3^\circ}$	∞	∞		42-3	181.4
Phenyldichloro-arsine	$C_6H_5 \cdot AsCl_2$	1.654^{20°	i.	s.	s.		−20	255-257
Phosgene (carbonyl chloride)	$O:C:Cl_2$	$1.392^{19^\circ}_{4}$	v.sl.s.	. .	. .		−104	$8.2^{756mm.}$
Phosphine	PH_3	1.146(A)	$26cc.^{17^\circ}$	s.	s.		−132.5	−85
Phosphorus (yellow)	P_4	1.82^{20°	0.0003	0.4	. .		44.1; ign. 34	280
Phosphorus pentasulfide	P_2S_5	2.03	d.	. .	. .		276	530
Phosphorus trichloride	PCl_3	$1.574^{20.8^\circ}_{4}$	d.	. .	s.		−111.8	$75.95^{760mm.}$

SELECTED CHEMICAL AND PHYSICAL DATA ON POTENTIAL ATMOSPHERIC CONTAMINANTS

(continued)

Element, Compound or Other Substance	Chemical Formula	Specific Gravity or Density	Solubility in 100 Parts			Diffusion Coefficient in air (cm.² sec.)	Melting Point, °C.	Boiling Point, °C.
			Water	Alcohol	Ether			
Propane	$CH_3{\cdot}CH_2{\cdot}CH_3$	1.562(A)	6.5cc.$^{17.8°}$	926cc.$^{16.6°}$	1299cc.$^{16.6°}$		−187.1	−42.2
iso-Propanol (iso-propyl alcohol)	$(CH_3)_2CHOH$	$0.789^{20°}_{4}$	∞	∞	∞		−85.8	82.5
Propene (propylene)	$CH_3{\cdot}CH_2{:}CH_2$	1.498(A)	44.6cc.	1200cc.	500cc.		−185	−48$^{749mm.}$
Propenol (allyl alcohol)	$CH_2{:}CH{\cdot}CH_2OH$	$0.854^{20°}_{4}$	∞	∞	∞		−129	96.6
n-Propyl acetate	$CH_3{\cdot}CO_2{\cdot}CH_2{\cdot}C_2H_5$	$0.886^{20°}_{4}$	$1.6^{16°}$	∞	∞		−92.5	101.6
n-Propyl butyrate	$C_3H_7{\cdot}CO_2{\cdot}C_3H_7$	$0.879^{15°}$	v.sl.s.	∞	∞		−95.2	142.7
iso-Propyl ether (iso-dipropyl ether)	$[(CH_3)_2CH]_2O$	$0.725^{20.0°}_{0}$	0.2	∞	∞		−60	68.5-9.0
n-Propyl formate	$H{\cdot}CO_2{\cdot}CH_2{\cdot}C_2H_5$	$0.901^{20°}_{4}$	$2.2^{22°}$	∞	∞		−92.9	81.3
n-Propyl nitrite	$CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}O{\cdot}NO$	$0.935^{20°}_{4}$	. .	s.	s.		. . .	57
Radon (radium emanation)	Rn	liq. 5.5	51cc.$^{0°}$	. .	. .		−71	−62
Selenium, as Se (steel gray)	Se_x	$4.8^{25°}$	i.	. .	. .		217	688
Silicontetrachloride	$SiCl_4$	. .	d.	. .	. .		subl.	d. 288
Stibine	SbH_3	$4.344^{15°}$(A)	$0.41^{10°}$	1500cc.	. .		−88	−17; (d.150)
Stoddard Solvent	(Special cleaning solvent of petroleum origin)							
Styrene monomer (phenyl ethylene)	$C_6H_5{\cdot}CH{:}CH_2$	$0.903^{20°}_{4}$	v.sl.s.	∞	∞		−31	145-6
Sulfur chloride, mono-	S_2Cl_2	1.687	d.	. .	s.		−80	138
Sulfuryl chloride (sulfuric oxychloride)	SO_2Cl_2	$1.667^{20°}_{4}$	d.	d.	. .		−54.1	69.1$^{760mm.}$
Sulfur dioxide	SO_2	2.264(A)	$22.8^{0°}$	s.	. .		−75.5	−10.0
Sulfuric acid	H_2SO_4	$1.834^{18°}_{4}$	∞	d.	. .		10.49	d. 340
Tellurium	Te	α, 6.24 β, 6.00	i.	. .	. .		452	1390

SELECTED CHEMICAL AND PHYSICAL DATA ON POTENTIAL ATMOSPHERIC CONTAMINANTS

(continued)

Element, Compound or Other Substance	Chemical Formula	Specific Gravity or Density	Solubility in 100 Parts			Diffusion Coefficient in air (cm.²/sec.)	Melting Point, °C.	Boiling Point, °C.
			Water	Alcohol	Ether			
Tetrabromomethane (carbon tetrabromide)	CBr_4	3.42	i.	s.	s.		α 48.4 β 90.1	189.5
1, 1, 2, 2- Tetrachloroethane	$Cl_2CH \cdot CH \cdot Cl_2$	$1.600^{20°}_{4°}$	i.	∞	∞		−36	146.3
Tetrachloroethylene	$Cl_2C{:}CCl_2$	$1.624^{15°}_{4}$	i.	∞	∞		−19	120.8
Tetraethyl lead	$(C_2H_5)_4Pb$	$1.659^{18°}_{4}$	i.	sl.s.	∞		−136	$152^{291mm.}$
Tetramethyl lead	$(CH_3)_4Pb$	$1.995^{20°}_{4}$	i.	∞	∞		−27.5	$110^{760mm.}$
Tetryl (2, 4, 6) (trinitrophenyl methylnitroamine)	$(NO_2)_3C_6H_2 \cdot N(CH_3)NO_2$	$1.57^{19°}$	i.	s.h.	s.		129	expl. 187
Thiophosgene (thiocarbonyl chloride)	$Cl_2C{:}S$	$1.509^{15°}$	d.	d.	s.		. . .	73.5
Toluene (toluol) (methyl benzene)	$C_6H_5 \cdot CH_3$	$0.866^{20°}_{4}$	i.	∞ abs.	∞		−95	110.8
Toluidine (o) (2-methyl aniline)	$CH_3 \cdot C_6H_4 \cdot NH_2$	$0.999^{20°}_{4}$	$1.5^{25°}$	∞	∞		−16.3 (−24.4)	199.7
Tribromomethane (bromoform)	$CHBr_3$	$2.890^{20°}_{4}$	sl.s.	∞	∞		8-9	150.5
Trichloroethane (1, 1, 1) (methyl chloroform)	$CH_3 \cdot CCl_3$	$1.325^{26°}_{4}$	i.	∞	∞		. . .	74.1
Trichloroethylene (ethylene trichloride)	$ClCH{:}CCl_2$	$1.466^{20°}_{20}$	$0.1^{25°}$	∞	∞		−73	87.2
Trichloronaphthalene (1, 4, 5)	$C_{10}H_5Cl_3$	. .	. .	v.s.h.	. .		133	. .
Trichloropropane (allyl trichloride)	$CH_2Cl \cdot CHCl \cdot CH_2Cl$	$1.417^{15°}_{4}$	i.	s.	s.		−14.7	156-8
Triethyl amine	$(C_2H_5)_3N$	$0.729^{20°}_{20}$	∞ <19°	∞	∞		−114.8	89.4
Triethyl antimony (triethyl stibine)	$(C_2H_5)_3Sb$	$1.324^{16°}$	. .	v.s.	v.s.		< −29	158-9

SELECTED CHEMICAL AND PHYSICAL DATA ON POTENTIAL ATMOSPHERIC CONTAMINANTS

(continued)

Element, Compound or Other Substance	Chemical Formula	Specific Gravity or Density	Solubility in 100 Parts			Diffusion Coefficient in air (cm.²/sec.)	Melting Point, °C.	Boiling Point, °C.
			Water	Alcohol	Ether			
Trifluoromethane (fluoroform)	CHF_3	..	75cc.	500cc.	..		...	$20^{40atm.}$
Trimethyl amine	$(CH_3)_3N$	$0.662^{-5°}$	$41^{19°}$	s.	s.		−124	3.2-3.8
Trimethyl antimony (trimethyl stibine)	$(CH_3)_3Sb$	$1.523^{15°}$	v.sl.s.	s.	s.		...	80.6
Trimethyl arsine	$(CH_3)_3As$	$1.124^{22°}$	sl.s.	..	..		...	52.8
Trinitrotoluene (TNT)	$(NO_2)_3C_6H_2 \cdot CH_3$	1.654	0.15h.	$1.5^{22°}$	$5^{33°}$		81-2	expl. 280
Turpentine	$C_{10}H_{16}$	0.860-0.865	..	..	s.		...	155-162
Vinyl chloride (chloro-ethylene)	$CH_2{:}CH \cdot Cl$	$0.908^{25°}_{25}$	sl.s.	s.	v.s.		−160	−12
Vinyl cyanide (acrylonitrile)	(See acrylonitrile)							
X-ray	(electromagnetic waves of short wave length)							
o-Xylene	$C_6H_4(CH_3)_2$	$0.881^{20°}_{4}$	i.	∞ abs.	∞		−25	144
Zinc oxide	ZnO	5.47	$0.00042^{18°}$	..	..		>1800	...

PERCEPTIBLE CONCENTRATIONS AND CHARACTERISTICS OF VARIOUS SUBSTANCES IN AIR

	Substance Conc. causing faint odor (mg/liter) (oz/1000 cu. ft.)
Acetaldehyde Pungent odor.	0.004
Acrolein Acrid odor of burning fat.	0.038
"Akrol" Acrid pine-tar odor. Irritating.	0.01
Allyl alcohol Alcoholic odor. Not unpleasant.	0.017
Allyl amine Odor similar to ammonia. Irritating.	0.067
Allyl disulfide Garlic odor. Decomposes	0.0001
Allyl isocyanide Sweet but repulsive odor. Nauseating.	0.0043
Allyl isothiocyanate Mustard oil odor. Nose and eye irritant.	0.0017
Allyl mercaptan Very disagreeable odor. Garlic.	**0.0005
Allyl sulfide Garlic odor.	0.00005
Ammonia Sharp, pungent odor.	0.037
Amylene Nauseating in high concentrations.	0.0066
Amyl acetate (iso) Banana odor.	0.0006
Amyl isovalerate (iso) Pleasant. Fruity.	0.0008
Amyl mercaptan (iso) Unpleasant.	0.0003
Amyl sulfide (iso) Strong and unpleasant odor.	0.0003
Benzaldehyde Odor of bitter almonds.	0.003
Benzyl chloride Lacrimator. Aromatic.	0.0016
Benzyl mercaptan Unpleasant odor.	0.00019
Benzyl sulfide Unpleasant odor.	0.0006
Bromacetone Pungent and stifling odor.	0.0005
Bromacetophenone	0.00064
Butylene (beta) Gas-house odor.	0.059
Butylene (gamma) Gas-house odor.	0.05
n-Butyl mercaptan Strong, unpleasant odor.	**0.0014
n-Butyl sulfide Unpleasant odor.	0.0011
Carbon disulfide Aromatic odor, slightly pungent.	0.0026
Chloracetophenone Apple blossom odor. Strong lacrimator.	**0.0085
B-chlorvinyldichlorarsine Odor of geraniums. (Lewisite)	0.014
Chlorine Pungent and irritating odor.	0.010
Chlorophenol Medicinal odor. Phenolic.	0.00018
Chloropicrin Fly paper odor.	0.0073

See Reference No. 5

PERCEPTIBLE CONCENTRATIONS AND CHARACTERISTICS OF VARIOUS SUBSTANCES IN AIR

(continued)

	Substance Conc. causing faint odor (mg/liter) (oz/1000 cu. ft.)
Coumarine Vanilla odor. Pleasant.	0.00034
Crotonaldehyde Eye and nose irritant.	**0.021
Crotyl mercaptan Skunk odor.	0.000029
Cyanogen chloride Bitter almonds.	0.0025
Dichlordiethyl sulfide Garlic or horseradish odor. (mustard gas)	0.0013
Dichlorethylene (trans.) Ethereal odor.	0.0043
Dimethyl trithiocarbonate Foul and disagreeable.	0.00018
Diphenylamine chlorarsine Slight odor.	0.0025
Diphenyl chlorarsine Shoe polish odor.	0.0003
Diphenyl cyanarsine Odor of bitter almonds and garlic.	0.0003
Diphenyl ether Geranium odor. Pleasant.	0.000069
Diphenyl sulfide Ethereal, but unpleasant odor.	0.000048
Diphosgene Suffocating, disagreeable odor.	0.0088
Dithio-ethylene glycol Disagreeable, garlic-like odor.	0.0016
Ethylene dichloride Aromatic. Ethereal.	0.025
Ethyl dichlorarsine Irritating, biting.	0.001
Ethyl isothiocyanate Mustard oil. Irritating odor.	0.038
Ethyl mercaptan Odor of decayed cabbage.	**0.00019
Ethyl selenide Garlic odor. Putrid and nauseating.	0.000062
Ethyl seleno mercaptan Very foul and disagreeable odor.	0.0000018
Ethyl sulfide Garlic-like, foul odor. Nauseating.	0.00025
Hydrogen cyanide Odor of bitter almonds.	0.001
Hydrogen sulfide Odor of rotten eggs. Nauseating.	0.0011
Methyl anthranilate Floral essence. Fruity odor.	0.00037
Methyl dichlorarsine Slight odor. Irritating.	0.0008
Methyl mercaptan Odor of decayed cabbage or onions.	0.0011
Methyl sulfide Odor of decayed vegetables.	0.0011
Methyl thiocyanate Odor of almonds. Unpleasant.	0.0096
Nitrobenzene Odor of bitter almonds	0.03
Oxidized oils Unpleasant and irritating.	0.0011
Ozone Slightly pungent, irritating odor.	0.001
Phenyl isocyanide Repulsive, nauseating odor.	**0.000029
Phenyl isothiocyanate Cinnamon odor. Pleasant.	0.0024
Phosgene Odor of ensilage or fresh-cut hay.	0.0044
Propionaldehyde Acrid, irritating odor.	0.002

PERCEPTIBLE CONCENTRATIONS AND CHARACTERISTICS OF VARIOUS SUBSTANCES IN AIR

(continued)

	Substance Conc. causing faint odor (mg/liter) (oz/1000 cu. ft.)
Propyl mercaptan Unpleasant odor.	0.000075
b-Propyl sulfide Foul odor. Nauseating.	0.00081
Pyridine Disagreeable, irritating odor.	**0.0037
Skatole Pungent, irritating odor.	0.009
Thiocresol Rancid, skunk-like odor.	0.0001
Thiophenol Putrid, nauseating odor.	0.000062
Trinitro butyl xylene Musk odor.	0.00001

*Based on data from references 1 and 2.

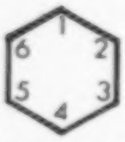
**Av. value of observations obtained with material of varying purity.

REFERENCES

1 Fieldnap, A.C., Sayers, R.R., et al. Warning Agents for Fuel Gases. U. S. Bureau of Mines. Monograph No. 4. 1931.

2 Prentis, A.M. Chemicals in War. McGraw Book Company. New York. 1937.

RING STRUCTURES OF POLYNUCLEAR ORGANIC POLLUTANTS



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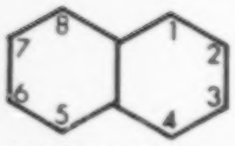

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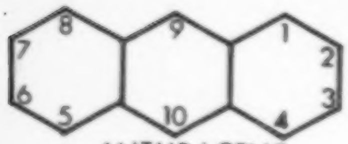
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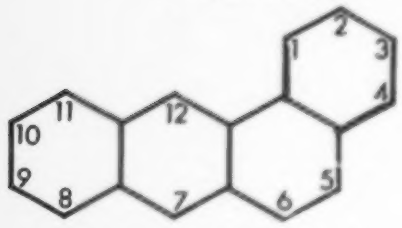
ANTHRACENE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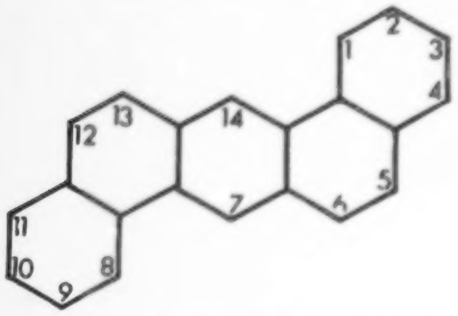
BENZ (a) ANTHRACENE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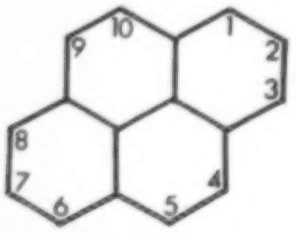
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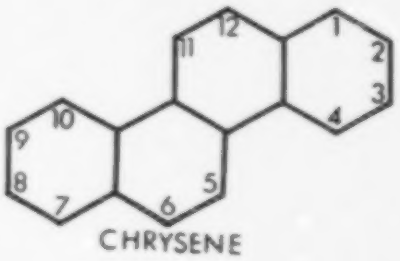
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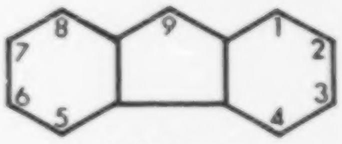
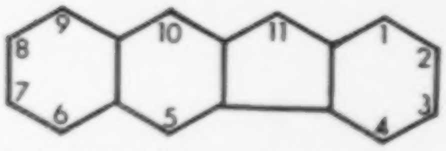


FLUORENE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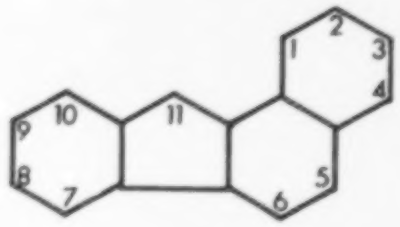
11 H - BENZO (b) FLUORENE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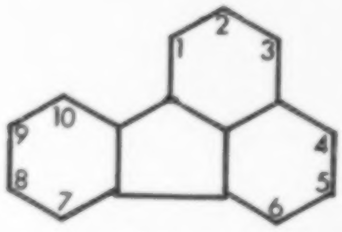
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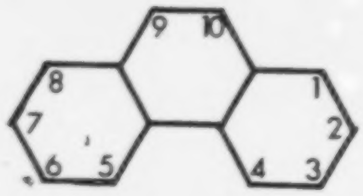
FLUORANTHENE

RING STRUCTURES OF POLYNUCLEAR ORGANIC POLLUTANTS
(continued)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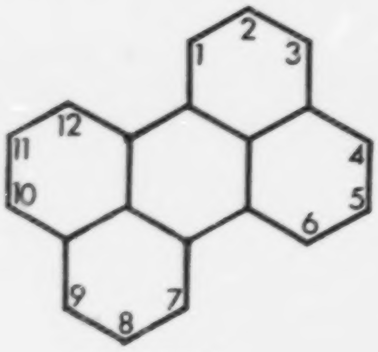
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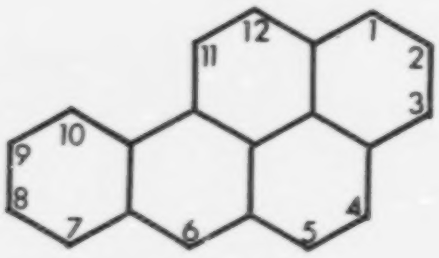
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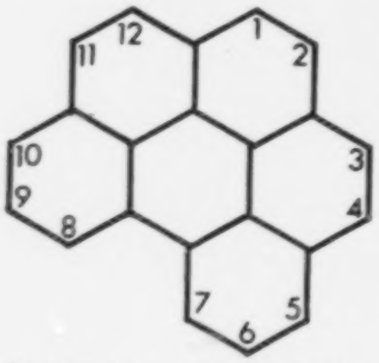
BENZO (a) PYRENE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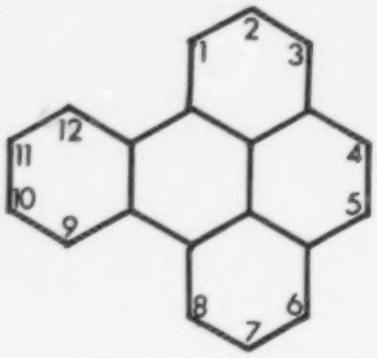
BENZO (g,h,i) PERYLENE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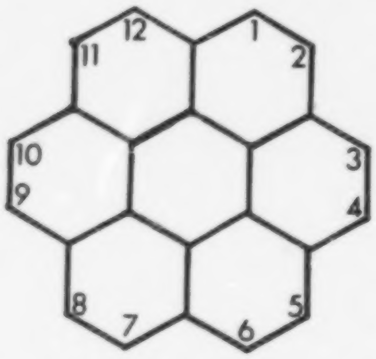
BENZO (e) PYRENE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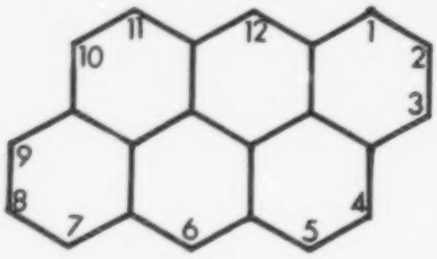
CORONENE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ANTHANTHRENE

SECTION 15 MISCELLANANEOUS CONVERSION FACTORS

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CONVERSION FACTORS – FORCE

1 gram weight *
$= 980.665$ dynes
1 kilogram weight
$= 9.80665 \times 10^5$ dynes
1 newton
$= 10^5$ dynes

1 pound weight *
$= 32.174$ poundals
$= 444822$ dynes
1 poundal
$= 13825.5$ dynes

* at standard gravity of 980.665 cm/sec^2 or 32.174 ft/sec^2

CONVERSION FACTORS – ENERGY AND WORK

1 erg
$= 1$ dyne-centimeter
$= 10^{-7}$ abs. joule
$= 2.38844 \times 10^{-8}$ ITcal.
$= 2.3892 \times 10^{-8}$ cal.$_{15}$
1 absolute joule (abs. joule)
$= 10^7$ ergs
$= 0.238844$ ITcal.
$= 0.23892$ cal.$_{15}$
1 kilogram-meter (kg.-m.)
$= 9.80665$ abs. joules
1 International Steam Tables calorie (ITcal.)*
$= 4.18684 \times 10^7$ ergs
$= 4.18684$ abs. joules
$= 1.00032$ cal.$_{15}$
$= \frac{1}{860 \times 10^3}$ Int. kw.-hr.
1 15° gram-calorie (cal.$_{15}$)*
$= 4.1855$ abs. joules
1 kilogram-calorie (Kcal.)
$= 10^3$ gram-calories
1 absolute kilowatt-hour (abs.kw.-hr.)
$= 3.6 \times 10^6$ abs. joules
1 mean International kilowatt-hr.
$= 1.00019$ abs. kw.-hr.
$= 860000$ ITcal.
$= 3.60068 \times 10^6$ abs. joules
$= 3412.756$ Btu

1 British thermal unit (Btu)
(The Btu used here is defined by the relationship:
1 Btu °F.$^{-1}$ lb.$^{-1}$ = 1 ITcal. °C.$^{-1}$ g.$^{-1}$)
$= 251.996$ ITcal.
$= 252.08$ cal.$_{15}$
$= 1055.07$ abs. joules
$= 0.00029302$ Int. kw.-hr.
1 foot-pound (ft.-lb.)
$= 1.35582$ abs. joules

CONVERSION FACTORS – POWER

1 absolute watt (abs. watt)
= 1 abs. joule sec.$^{-1}$
= 0.238844 ITcal. sec.$^{-1}$
= 14.33062 ITcal. min.$^{-1}$
= 0.23892 cal.$_{15}$ sec.$^{-1}$
= 14.33527 cal.$_{15}$ min.$^{-1}$
= 0.056368 Btu min.$^{-1}$
1 mean International watt
= 1.00019 abs. watts
1 ITcal. sec.$^{-1}$
= 4.18684 abs. watts
1 ITcal. min.$^{-1}$
= 0.069781 abs. watt
1 cal.$_{15}$ sec.$^{-1}$
= 4.1855 abs. watts
1 cal.$_{15}$ min.$^{-1}$
= 0.069758 abs. watt

1 horsepower, electrical, U. S., Brit.
= 746 abs. watts
1 horsepower (mechanical)
= 550 ft. lb. sec.$^{-1}$
= 745.70 abs. watts
1 horsepower (continental)
= 736 abs. watts
1 cheval-vapeur
= 75 kg. m. sec.$^{-1}$
= 735.499 abs. watts
1 Btu min.$^{-1}$
= 175.844 abs. watts
= 251.996 ITcal. min.$^{-1}$
= 252.08 cal.$_{15}$ min.$^{-1}$

CONVERSION FACTORS – ENERGY PER UNIT AREA

1 langley (ly.)
= 1 cal.$_{15}$ cm.$^{-2}$
= 4.1855 abs. joules cm.$^{-2}$
= 0.011624 Int. kw.-hr. m.$^{-2}$
= 3.6855 Btu ft.$^{-2}$
1 abs. joule cm.$^{-2}$
= 0.23892 cal.$_{15}$ cm.$^{-2}$
= 0.00277725 Int. kw.-hr. m.$^{-2}$
= 0.88054 Btu ft.$^{-2}$
1 Int. kw.-hr. m.$^{-2}$
= 86.028 cal.$_{15}$ cm.$^{-2}$
= 360.068 abs. joules cm.$^{-2}$

1 Btu ft.$^{-2}$
= 0.27133 cal.$_{15}$ cm.$^{-2}$
= 1.13566 abs. joules cm.$^{-2}$

CONVERSION FACTORS – POWER PER UNIT AREA

1 cal.$_{15}$ cm.$^{-2}$ min.$^{-1}$
= 1 ly. min.$^{-1}$
= 0.069758 abs. watt cm.$^{-2}$
= 0.069745 Int. watt cm.$^{-2}$
= 69.745 Int. kw. dekameter^{-2}
= 3.6855 Btu ft.$^{-2}$ min.$^{-1}$
= 1440 cal.$_{15}$ cm.$^{-2}$ day^{-1}
= 5307.1 Btu ft.$^{-2}$ day^{-1}

1 Btu ft.$^{-2}$ min.$^{-1}$
= 0.27133 cal.$_{15}$ cm.$^{-2}$ min.$^{-1}$
= 0.0189277 abs. watt cm.$^{-2}$

See Reference No. 1

CONVERSION FACTORS – ILLUMINATION, BRIGHTNESS, ETC.

The total luminous flux from a source of unit spherical candlepower is 4π lumens.

1 lux (lx.)
= 1 lumen incident per square meter
= 0.0001 ph.
= 0.09290 ft.-c.

1 phot (ph.)
= 1 lumen incident per square centimeter

1 stilb (sb.)
= 1 Int. c. cm.^{-2}
= π L. = 3.142 L.
= 2919 ft.-L.

1 lambert (L.)
= $1/\pi$ sb. = 0.3183 sb.
= 2.054 c. in.^{-2}
= 929 ft.-L.

1 millilambert (mL.)
= 10^{-3} L.

1 apostilb, in International units
$= 1/(\pi \times 10^4)\ \text{sb.} = \dfrac{1}{\pi \times 10^4}$ stilb
= 0.1 mL.

1 apostilb, in German (Hefner) units
= 0.09 mL.

1 footcandle (ft.-c.)
= 1 lumen incident per square foot
= 10.76 lx.

1 candle per in.^2 (c. in.^{-2})
= 0.1550 sb.
= 0.487 L.
= 452.4 ft.-L.

1 footlambert (ft.-L.)
= 0.0003426 sb.
= 0.001076 L.
= 0.002211 c. in.^{-2}

1 candle per ft.^2
= 3.142 ft.-L.

Luminous efficiency: At wave length of maximum luminosity *0.555 μ* for photopic vision, the luminous efficiency is 680 lumens per watt, corresponding to a ***minimum*** "mechanical equivalent of light" of 0.00151 watt per lumen.

See Reference No. 1

CONVERSION FACTORS - EMISSION RATES

Given units \ Desired units	gms/sec	gms/min	kg/hr	kg/day	lbs/min	lbs/hr	lbs/day	tons/hr	tons/day	tons/yr
gms/sec	1.0	60.0	3.6	8.640 × 10	1.3228 × 10^{-1}	7.9367	1.9048 × 10^{2}	3.9683 × 10^{-3}	9.5240 × 10^{-2}	3.4763 × 10
gms/min	1.6667 × 10^{-2}	1.0	6.0 × 10^{-2}	1.4400	2.2046 × 10^{-3}	1.3228 × 10^{-1}	3.1747	6.6139 × 10^{-5}	1.5873 × 10^{-3}	5.7938 × 10^{-1}
kg/hr	2.7778 × 10^{-1}	16.667	1.0	2.4000 × 10	3.6744 × 10^{-2}	2.2046	5.2911 × 10	1.1023 × 10^{-3}	2.6456 × 10^{-2}	9.6563
kg/day	1.1574 × 10^{-2}	6.9444 × 10^{-1}	4.1667 × 10^{-2}	1.0	1.5310 × 10^{-3}	9.1860 × 10^{-2}	2.2046	4.5930 × 10^{-5}	1.1023 × 10^{-3}	4.0235 × 10^{-1}
lbs/min	7.5598	4.5359 × 10^{2}	2.7215 × 10	6.5317 × 10^{2}	1.0	60.0	1.44 × 10^{3}	3.000 × 10^{-2}	7.2000 × 10^{-1}	2.6280 × 10^{2}
lbs/hr	1.2600 × 10^{-1}	7.5598	4.5359 × 10^{-1}	1.0886 × 10	1.6667 × 10^{-2}	1.0	24.0	5.0000 × 10^{-4}	1.2000 × 10^{-2}	4.3800
lbs/day	5.2499 × 10^{-3}	3.1499 × 10^{-1}	1.8900 × 10^{-2}	4.5359 × 10^{-1}	6.9444 × 10^{-4}	4.1667 × 10^{-2}	1.0	2.0833 × 10^{-5}	5.0000 × 10^{-4}	1.8250 × 10^{-1}
tons/hr	2.5199 × 10^{2}	1.5120 × 10^{4}	9.0718 × 10^{2}	2.1772 × 10^{4}	3.3333 × 10	2.0 × 10^{3}	4.8000 × 10^{4}	1.0	24.0	8.7600 × 10^{3}
tons/day	1.0500 × 10	6.2999 × 10^{2}	3.7799 × 10	9.0718 × 10^{2}	1.3889	8.3333 × 10	2.0 × 10^{3}	4.1667 × 10^{-2}	1.0	365.0
tons/yr	2.8766 × 10^{-2}	1.7260	1.0356 × 10^{-1}	2.4854	3.8052 × 10^{-3}	2.2831 × 10^{-1}	5.4795	1.1416 × 10^{-4}	2.7397 × 10^{-3}	1.0

To convert a value from a given unit to a desired unit, multiply the given value by the factor opposite the given units and beneath the desired units.

SECTION 16 MEDICAL

Absolute Lung Volumes, Definitions and Conversions 16-1
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ABSOLUTE LUNG VOLUMES, DEFINITIONS AND CONVERSIONS

I. ABSOLUTE LUNG VOLUMES, DEFINITIONS AND CONVERSIONS: ATPS, BTPS, AND STPD CONDITIONS

Gas volume in the lung exists at Body Temperature and atmospheric Pressure and is completely Saturated with water vapor at body temperature--hence the designation BTPS.

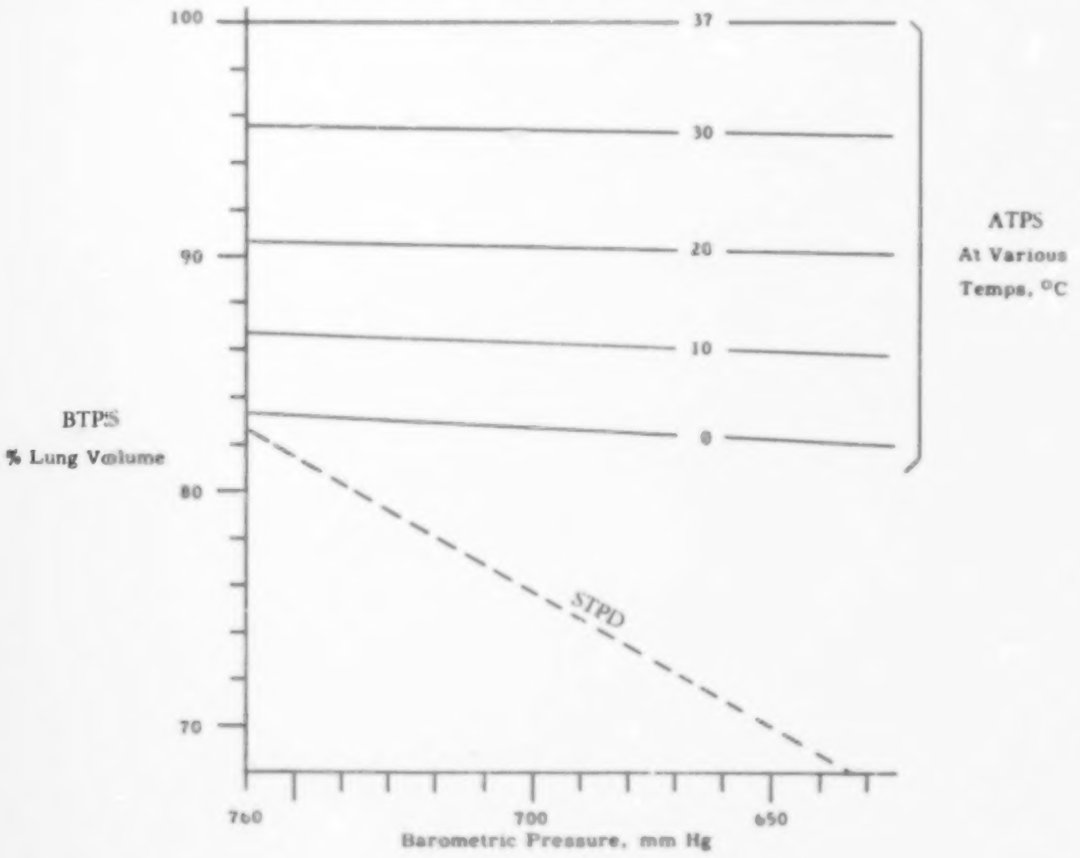
However, once the gas has been blown into a measuring device such as a spirometer, the temperature will have dropped to the spirometer or Ambient Temperature; although the gas volume is still Saturated with water vapor at the lower ambient temperature the water vapor volume is reduced. The Pressure of the atmosphere is the same. This condition is designated ATPS.

Under average laboratory conditions (ATPS), the "true" lung volume (BTPS) will shrink, in response to the ambient temperature and barometric pressure, to perhaps 93%, as shown in the figure below. If this lung volume is then converted to conditions of Standard Temperature and Pressure with all water vapor removed (or Dry), this STPD value will be approximately 83% of the BTPS lung volume--sometimes even less in accordance with the barometric pressure (also as shown in the figure below).

It must also be borne in mind that lung volume measurements are often made on closed breathing circuits which contain a CO_2 absorber. Any volume expired into such a system will, of course, be automatically reduced by the percentage of CO_2 in the expired air; for a Vital Capacity obtained after full inspiration and before maximal expiration, this reduction may well be of the order of 2-3%. This discrepancy must be considered in making reference to "absolute volumes."

All lung volumes are normally recorded at ATPS conditions. Conversion to BTPS conditions which represent true or anatomical lung volume requires knowledge of room or spirometer temperature and approximate barometric pressure.

True lung volume (BTPS) = lung volume at ATPS $\times \frac{310}{273+t} \times \frac{P_B - pH_2O}{P_B - 47}$, where t = spirometer temperature in degrees C; P_B = barometric pressure in mm Hg; and pH_2O = vapor pressure of water at spirometer temperature t. 310 is absolute body temperature of 37°C, and 47 mm Hg is the vapor pressure of water at 37°C.

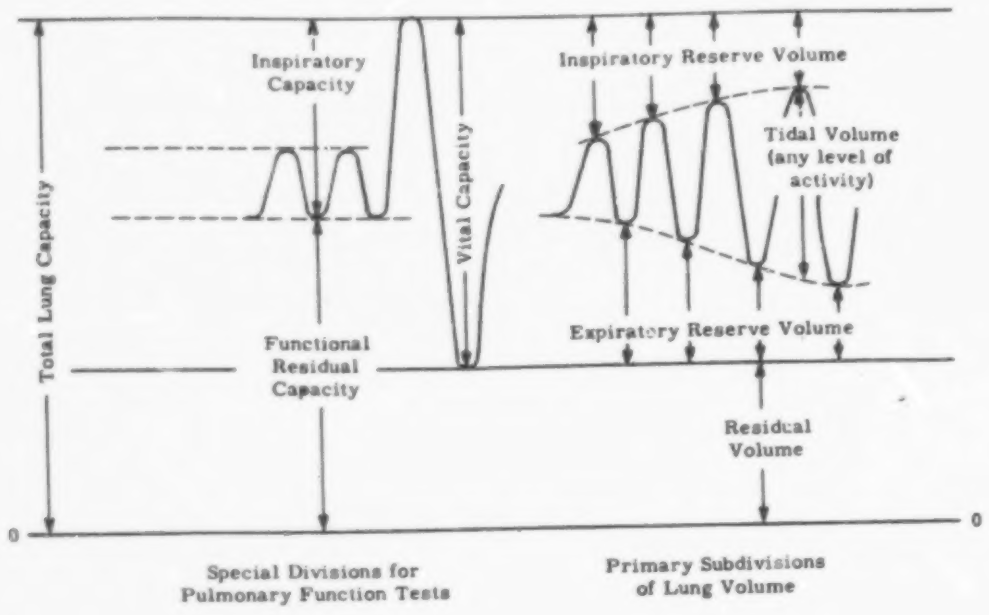


See Reference No. 18

SUBDIVISIONS OF LUNG VOLUME: MAN

DIAGRAM

Volumes corrected to BTPS conditions (cf Page 1).


Total Lung Capacity
Inspiratory Capacity
Vital Capacity
Inspiratory Reserve Volume
Tidal Volume (any level of activity)
Functional Residual Capacity
Expiratory Reserve Volume
Residual Volume
0
0
Special Divisions for Pulmonary Function Tests
Primary Subdivisions of Lung Volume

Reference: Comroe, J. H., Jr., et al, Fed. Proc. 9:602, 1950.

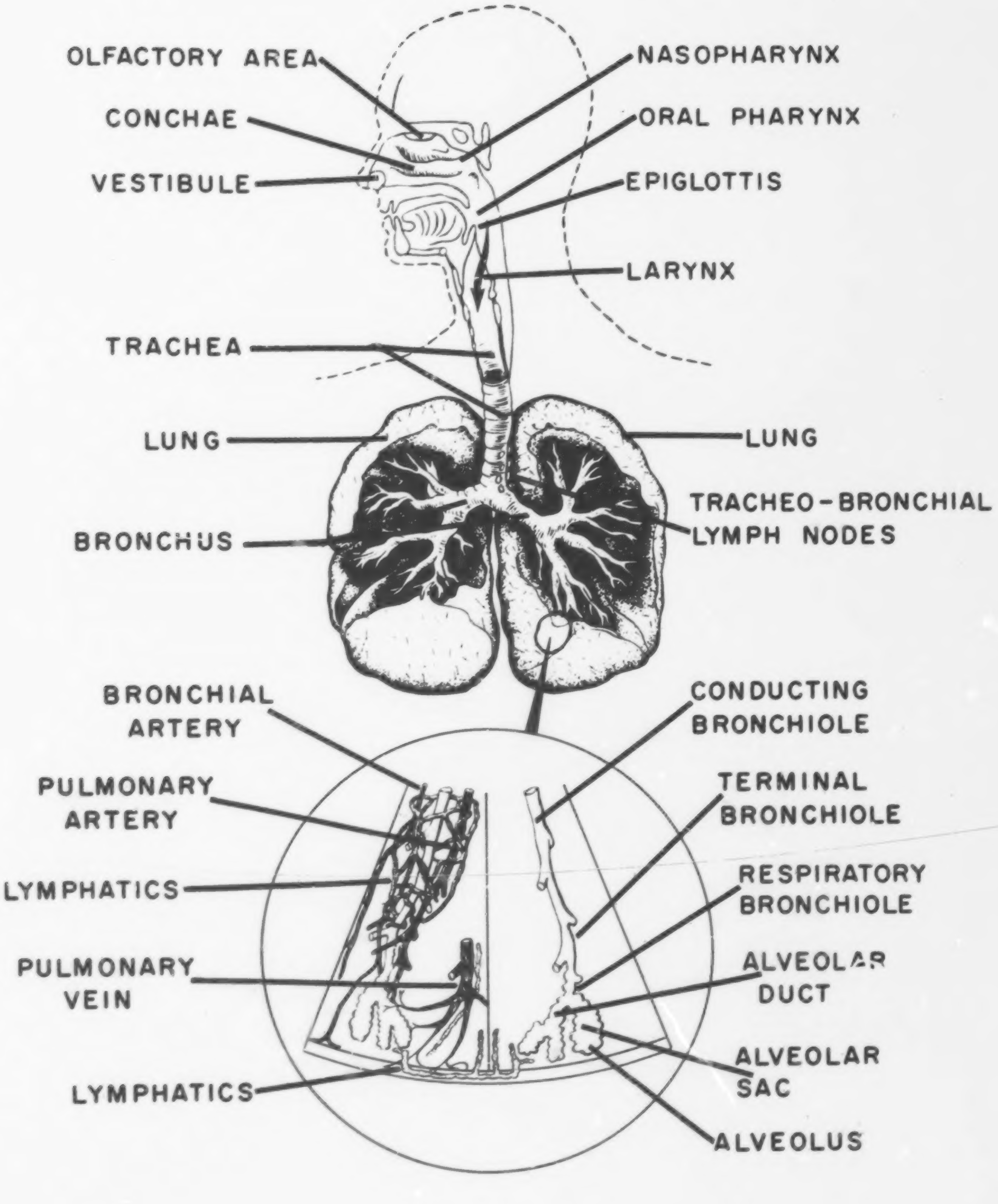
STANDARD TERMINOLOGY OF LUNG CAPACITY

	Standardized Term	Definition	Previous Term
1	Inspiratory reserve volume	Maximal volume that can be inspired from end-tidal inspiration.	Complemental air. Complementary air. Complemental air minus tidal air. Inspiratory capacity minus tidal volume.
2	Tidal volume	Volume of gas inspired or expired during each respiratory cycle.	Tidal air.
3	Expiratory reserve volume	Maximal volume that can be expired from resting expiratory level.	Supplemental air. Reserve air.
4	Residual volume	Volume of gas in lungs at end of maximal expiration.	Residual air. Residual capacity.
5	Inspiratory capacity	Maximal volume that can be inspired from resting expiratory level.	Complemental air. Complementary air.
6	Functional residual capacity	Volume of gas in lungs at resting expiratory level.	Functional residual air. Equilibrium capacity. Mid-capacity. Normal capacity.
7	Vital capacity	Maximal volume that can be expired after maximal inspiration.	Vital capacity.
8	Total lung capacity	Volume of gas in lungs at end of maximal inspiration.	Total lung volume.

Reference: Comroe, J. H., Jr., "The Lung," Chicago: The Year Book Publishers, 1956.

See Reference No. 18

LUNG LOBULE


OLFACTORY AREA
NASOPHARYNX
CONCHAE
ORAL PHARYNX
VESTIBULE
EPIGLOTTIS
LARYNX
TRACHEA
LUNG
LUNG
TRACHEO-BRONCHIAL LYMPH NODES
BRONCHUS
BRONCHIAL ARTERY
CONDUCTING BRONCHIOLE
PULMONARY ARTERY
TERMINAL BRONCHIOLE
RESPIRATORY BRONCHIOLE
LYMPHATICS
PULMONARY VEIN
ALVEOLAR DUCT
ALVEOLAR SAC
LYMPHATICS
ALVEOLUS

See Reference No. 23

REPRESENTATION OF RESPIRATORY SYSTEM

	Lung parts	Branching factor	No.	Inside dia., cm	Length, cm	Cross-sectional area, cm^2	Flow speed^b cm/second	Flow-through time, second
A	Trachea	1	1	1.3	11.0	1.3	150	0.07
B	Main bronchi	2	2	0.75	6.5	1.1	180	0.04
C	Bronchi, first order	6	12	0.4	3.0	1.5	130	0.02
D	Bronchi, second order	8	100	0.2	1.5	3.1	65	0.02
E	Bronchi, third order	8	770	0.15	0.5	14	14	0.04
F	Bronchiole terminales	70	5.4×10^4	0.06	0.3	150	1.3	0.22
G	Bronchiole respiratorii	2	1.1×10^5	0.05	0.15	220	0.9	0.17
H	Ductuli alveolarii	240	2.6×10^7	0.02	0.02	8200	0.025	0.82
I	Saculi alveolarii	2	5.2×10^7	0.03	0.03	1.47×10^{5c}	approx. 0	1.2

[a] According to Findeisen.[85]

[b] For ventilation rate of 200 cm^3 per second.

[c] Total surface area of sphere-shaped saculi alveolarii.

REPRESENTATION OF RESPIRATORY TRACT

Region (a)	Number	Volume, cm^3	Relative volume (V)	Diameter ($2R$), cm	Length, cm	Cross-sectional area, cm^2	Velocity, cm/second	Passage time (r'), second	Fraction passing
Mouth (1)	1	20	0.04	2	7	3	100	0.07	1.00
Pharynx (2)	1	20	0.04	3	3	7	45^b	0.07	0.96
Trachea (3)	1	24	0.06	1.6	11	2	150	0.07	0.92
Prim. bronchi (4)	2	10	0.02	1.0	6.5	1.6	190	0.03	0.86
Sec. bronchi (5)	12	4	0.01	0.4	3	1.5	200	0.015	0.84
Ter. bronchi (6)	100	5	0.01	0.2	1.5	3.1	100	0.015	0.83
Quart. bronchi (7)	770	7	0.015	0.15	0.5	14	22	0.02	0.82
Terminal bronchioles (8)	5.4×10^4	45	0.10	0.06	0.3	170	2	0.15	0.81
Resp. bronchi (9)	1.1×10^5	33	0.07	0.05	0.15	300	1.4	0.10	0.72
Alveolar ducts (10)	2.6×10^7	(160)^c	(0.63)	(0.02)^c	0.02	8000	—	—	0.65
Alveolar sacs (11)	5.2×10^7	(730)^c	—	(0.03)^c	(0.03)^c	—	—	—	—

[a] According to Landahl. Revised, 1962, from original as presented in ref. 142.

[b] Glottis velocity = 150.

[c] Values as estimated. These values are corrected to 2.5 liters at end of expiration.

RESPIRATORY RATE, MINUTE AND TIDAL VOLUMES

	Body weight kg*	Condition	Respiratory rate (breaths/min.)	Tidal volume** (ml)	Minute volume (l/min.)
Man	68. 5	Resting	11. 7 (10. 1-13. 1)	750 (575-895)	7. 43 (5. 8-10. 3)
		Light work	17. 1 (15. 7-18. 2)	1673 (1510-1770)	28. 6 (27. 3-30. 9)
		Heavy work	21. 2 (18. 6-23. 3)	2030 (1900-2110)	42. 9 (39. 3-45. 2)
Woman	54	Resting	11. 7 (10. 4-13. 0)	339 (285-393)	4. 5 (4. 0-5. 1)
		Light work	19. 0	860 (836-885)	16. 3 (15. 9-16. 8)
		Heavy work	30. 0 (25. 0-35. 3)	880 (490-1270)	24. 5 (17. 3-31. 8)

*1 kg = 2. 205 pounds

68. 5 kg = 151 pounds

54 kg = 119 pounds

**Air inspired or expired in one respiration.

DATA USEFUL IN PULMONARY PHYSIOLOGY

Values for a healthy, resting, recumbent young man (1.7 sq m surface area) breathing air, unless other conditions are specified. These values may change with position, age, size, sex and altitude; there is variability among members of a homogenous group under standard conditions.

	Variable	Value
	Lung Volumes (BTPS)	
1	Inspiratory capacity	3600 ml
2	Expiratory reserve volume	1200 ml
3	Vital capacity	4800 ml
4	Residual volume	1200 ml
5	Functional residual capacity	2400 ml
6	Total lung capacity	6000 ml
7	Residual volume/total lung capacity x 100	20%
	Ventilation (BTPS)	
8	Tidal volume	500 ml
9	Frequency	12 respirations/min
10	Minute volume	6000 ml/min
11	Respiratory dead space	150 ml
12	Alveolar ventilation	4200 ml/min
	Distribution of Inspired Gas	
13	Single-breath test (% increase N_2 for 500 ml expired alveolar gas)	<1.5% N_2
14	Pulmonary nitrogen emptying rate (7 min test)	<2.5% N_2
15	Helium closed circuit (mixing efficiency related to perfect mixing)	76%
	Alveolar Ventilation/Pulmonary Capillary Blood Flow	
16	Alveolar ventilation (L/min)/blood flow (L/min)	0.8
17	Physiological shunt/cardiac output x 100	<7%
18	Physiological dead space/tidal volume x 100	<30%
	Pulmonary Circulation	
19	Pulmonary artery pressure	25/8 mm Hg
20	Pulmonary capillary blood pressure	8 mm Hg
21	Pulmonary capillary blood flow	5400 ml/min
22	Pulmonary capillary blood volume	60-100 ml
	Alveolar Gas	
23	O_2 partial pressure	104 mm Hg
24	CO_2 partial pressure	40 mm Hg
	Diffusion and Gas Exchange	
25	O_2 consumption (STPD)	250 ml/min
26	CO_2 output (STPD)	200 ml/min
27	Respiratory exchange ratio, (CO_2 output/O_2 uptake)	0.8
28	Diffusing capacity, O_2 (STPD)	20 ml O_2/min/mm Hg
29	Diffusing capacity, CO (steady state) (STPD)	17 ml CO/min/mm Hg
30	Diffusing capacity, CO (single breath) (STPD)	17 ml CO/min/mm Hg
31	Fractional CO uptake	53%
32	Maximal diffusing capacity (exercise) (STPD)	60 ml/min/mm Hg
	Arterial Blood	
33	O_2 saturation (% saturation of Hb with O_2)	97.1%
34	O_2 tension	95 mm Hg
35	CO_2 tension	40 mm Hg
36	Alveolar-arterial pO_2 difference	9 mm Hg
37	Alveolar-arterial pO_2 difference (12-14% O_2)	10 mm Hg
38	Alveolar-arterial pO_2 difference (100% O_2)	35 mm Hg
39	O_2 saturation (100% O_2)	100% (+1.91-2.00 ml dissolved O_2/100 ml blood)
40	pH	7.40
	Mechanics of Breathing	
41	Maximal breathing capacity (BTPS)	125-170 L/min
42	Timed vital capacity (% of total vital capacity)	83% in 1 sec, 97% in 3 sec
43	Maximal expiratory flow rate (for 1 L) (ATPS)	400 L/min
44	Maximal inspiratory flow rate (for 1 L) (ATPS)	300 L/min
45	Compliance of lungs and thorax	0.1 L/cm H_2O
46	Compliance of lungs	0.2 L/cm H_2O
47	Airway resistance	1.6 cm H_2O/L/sec
48	Work of quiet breathing	0.5 kg-m/min
49	Maximal work of breathing	10 kg-m/breath
50	Maximal inspiratory and expiratory pressures	60-100 mm Hg

Reference: Comroe, J. H., Jr., et al, p 171, "The Lung," Chicago: The Year Book Publishers, 1956.

MEAN RESPIRATORY AIR FLOW MEASUREMENTS

HEALTHY YOUNG MEN[a]

Work rate	Sedentary	0 kg-m/min	208 kg-m/min	415 kg-m/min	622 kg-m/min	830 kg-m/min	1107 kg-m/min	1384 kg-m/min	1660 kg-m/min
Subjects in mean	29	12	12	14	12	59	46	8	6
Pulse rate per min	73	93	105	116	128	158	166	177	178
Respiration rate per min	14.6	19.6	21.2	22.7	23.0	30.4	34.8	40.7	47.6
Minute volume, liters	10.3	14.2	20.8	29.9	37.3	54.7	75.3	104.0	113.8
Maximum inspiratory flow, liter/min	40	49	63	84	100	149	194	254	286
Maximum expiratory flow, liter/min	32	43	58	85	107	154	211	314	322
Maximum inspiratory flow (minute volume)	3.9	3.4	3.1	2.8	2.7	2.7	2.6	2.4	2.5
Maximum expiratory flow (minute volume)	3.1	3.0	2.8	2.9	2.9	2.8	2.8	3.0	2.8
(Maximum inspir. flow)/(maximum expir. flow)	1.3	1.1	1.1	1.0	1.0	1.0	0.9	0.8	0.9
(Inspiratory cycle)/(total cycle)	39.2	41.4	44.1	46.8	48.2	48.3	49.4	51.3	50.2
(Expiratory cycle)/(total cycle)	57.6	58.2	55.8	53.2	51.7	51.6	50.6	48.7	49.8
Rise/(inspiratory cycle)	17.7	20.7	16.3	13.3	13.8	11.2	14.3	16.9	18.2
(Sustained flow)/(inspiratory cycle)	58.7	59.0	65.3	69.4	65.9	71.1	69.8	68.1	68.0
(Maximum flow occurrence)/(expiratory cycle), %	27.7	37.5	47.9	46.8	46.7	45.1	44.0	44.4	50.4
Rise/(expiratory cycle), %	11.8	20.3	23.5	21.6	22.3	18.8	19.0	21.1	21.8
(Sustained flow)/(expiratory cycle), %	49.3	37.4	51.0	52.3	53.1	57.7	59.7	57.1	61.3
Oxygen deficit, %	3.56[b]	3.89	4.30	4.41	4.63	4.31	4.12	3.39	3.44
Oxygen consumption, ml/min	306	496	800	1176	1545	2075	2723	3114	3413
Carbon dioxide production, ml/min	261	425	695	1068	1432	2017	2723	3399	3598
Respiratory quotient	0.85	0.86	0.87	0.91	0.93	0.97	1.00	1.09	1.06

[a] After Silverman and associates, courtesy *A.M.A. Arch. Ind. Hyg. Occupational Med.*

[b] Values from 11 subjects are included in mean values for gas analyses.

See Reference No. 19

BLOOD ERYTHROCYTE AND HEMOGLOBIN VALUES AT OR NEAR SEA LEVEL: MAN[1]

	Country	Place[2]	RBC Count millions/mm³ blood	Blood Hemoglobin Concentration g/100ml blood	Corpuscle Hb Content[3] μμg
	(A)	(B)	(C)	(D)	(E)
1	U. S.	Portland, Oregon	5.39	15.8	29.3
2	U. S.	Portland, Oregon	5.42	15.8	29.2
3	U. S.	New Orleans	5.85	15.9	27.2
4	U. S.	New Orleans	5.26	15.6	29.7
5	U. S.	Kansas	4.84	15.1	31.2
6	U. S.	Omaha	4.69	15.0	32.0
7	U. S.	Kansas	5.11	15.0	29.4
8	Argentina	Buenos Aires	5.50	15.4	28.0
9	Argentina	Buenos Aires	5.30	14.8	27.9
10	Denmark	Copenhagen	5.07	15.0	29.6
11	Germany	Jena	5.06	16.0	31.6
12	Germany	Giessen	4.96	16.0	32.3
13	Hawaii	Honolulu	5.08	15.1	29.7
14	India	Calcutta	5.36	14.8	27.6
15	India	Bombay	5.11	15.4	30.1
16	Norway	Oslo	5.52	16.2	29.3
17	Peru	Lima	5.26	15.7	29.8
18	Peru	Lima	5.14	16.0	31.1
19	Summary, U. S.		5.22	15.5	29.7
20	Summary, all countries		5.22	15.5	29.7

/1/ Males. /2/ Altitudes of less than 0.4 Km. /3/ Mean Corpuscular Hemoglobin (M.C.H.).

BLOOD ERYTHROCYTE AND HEMOGLOBIN VALUES AT ALTITUDE: MAN[1]

Residents (R); Sojourners (S).								
	Country	Place	Altitude Km		RBC Count millions/mm^3 blood		Blood Hemoglobin Concentration g/100ml blood	Corpuscle Hb Content[2] μμg
	(A)	(B)	(C)		(D)		(E)	(F)
1	Sea Level[3]		<0.4	R	5.22	R	15.5	29.7
2	Argentina	Tucuman	0.4	R	5.31	R	16.1	30.3
3	Canada	Saskatchewan	0.5	R	5.52	R	15.6	28.3
4	Switzerland	Zurich	0.5	R	5.00	R	15.0	30.0
5	U. S.	Denver, Colo.	1.5	R	5.42	R	16.5	30.4
6	So. Africa	Johannesburg	1.8	R	5.99	R	14.7	24.5
7	Mexico	Mexico City	2.3	R	7.35	R	18.4	25.0
8	Mexico	Mexico City	2.3	R	5.38	R	17.7	32.9
9	Chile	Chuquicamata	2.8	S	5.24	S	15.9	30.3
10	Chile	Ollague	3.7	S	5.54	S	17.0	30.7
11	Peru	Oroya	3.7	R	5.67	R	18.8	33.2
12	Argentina	Mina Aguilar	4.5	R	6.46	R	19.4	30.0
13	Peru	Morococha	4.5	R	6.15	R	20.8	33.8
14	Chile	Montt	4.7	S	5.84	S	17.6	30.1
15	Chile	Quilcha	5.3	R	7.37	R	22.6	30.7
16	Chile	Quilcha	5.3	S	5.95	S	18.4	30.9
17	Chile	Punta	6.1	S	5.77	S	18.3	31.7
18	India	Nanga Parbat	7.0	S	8.10	S	24.7	30.5

/1/ Males. /2/ Mean Corpuscular Hemoglobin (M.C.H.). /3/ Altitudes of less than 0.4 Km

See Reference No. 22

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SQUARES AND SQUARE ROOTS

N	N^2	$\sqrt{N}$	$\sqrt{10N}$	N	N^2	$\sqrt{N}$	$\sqrt{10N}$	N	N^2	$\sqrt{N}$	$\sqrt{10N}$
1.00	1.0000	1.00000	3.16228	**1.60**	2.5600	1.26491	4.00000	**2.20**	4.8400	1.48324	4.69042
1.01	1.0201	1.00499	3.17805	1.61	2.5921	1.26886	4.01248	2.21	4.8841	1.48661	4.70106
1.02	1.0404	1.00995	3.19374	1.62	2.6244	1.27279	4.02492	2.22	4.9284	1.48997	4.71169
1.03	1.0609	1.01489	3.20936	1.63	2.6569	1.27671	4.03733	2.23	4.9729	1.49332	4.72229
1.04	1.0816	1.01980	3.22490	1.64	2.6896	1.28062	4.04969	2.24	5.0176	1.49666	4.73286
1.05	1.1025	1.02470	3.24037	**1.65**	2.7225	1.28452	4.06202	**2.25**	5.0625	1.50000	4.74342
1.06	1.1236	1.02956	3.25576	1.66	2.7556	1.28841	4.07431	2.26	5.1076	1.50333	4.75395
1.07	1.1449	1.03441	3.27109	1.67	2.7889	1.29228	4.08656	2.27	5.1529	1.50665	4.76445
1.08	1.1664	1.03923	3.28634	1.68	2.8224	1.29615	4.09878	2.28	5.1984	1.50997	4.77493
1.09	1.1881	1.04403	3.30151	1.69	2.8561	1.30000	4.11096	2.29	5.2441	1.51327	4.78539
1.10	1.2100	1.04881	3.31662	**1.70**	2.8900	1.30384	4.12311	**2.30**	5.2900	1.51658	4.79583
1.11	1.2321	1.05357	3.33167	1.71	2.9241	1.30767	4.13521	2.31	5.3361	1.51987	4.80625
1.12	1.2544	1.05830	3.34664	1.72	2.9584	1.31149	4.14729	2.32	5.3824	1.52315	4.81664
1.13	1.2769	1.06301	3.36155	1.73	2.9929	1.31529	4.15933	2.33	5.4289	1.52643	4.82701
1.14	1.2996	1.06771	3.37639	1.74	3.0276	1.31909	4.17133	2.34	5.4756	1.52971	4.83735
1.15	1.3225	1.07238	3.39116	**1.75**	3.0625	1.32288	4.18330	**2.35**	5.5225	1.53297	4.84768
1.16	1.3456	1.07703	3.40588	1.76	3.0976	1.32665	4.19524	2.36	5.5696	1.53623	4.85798
1.17	1.3689	1.08167	3.42053	1.77	3.1329	1.33041	4.20714	2.37	5.6169	1.53948	4.86826
1.18	1.3924	1.08628	3.43511	1.78	3.1684	1.33417	4.21900	2.38	5.6644	1.54272	4.87852
1.19	1.4161	1.09087	3.44964	1.79	3.2041	1.33791	4.23084	2.39	5.7121	1.54596	4.88876
1.20	1.4400	1.09545	3.46410	**1.80**	3.2400	1.34164	4.24264	**2.40**	5.7600	1.54919	4.89898
1.21	1.4641	1.10000	3.47851	1.81	3.2761	1.34536	4.25441	2.41	5.8081	1.55242	4.90918
1.22	1.4884	1.10454	3.49285	1.82	3.3124	1.34907	4.26615	2.42	5.8564	1.55563	4.91935
1.23	1.5129	1.10905	3.50714	1.83	3.3489	1.35277	4.27785	2.43	5.9049	1.55885	4.92950
1.24	1.5376	1.11355	3.52136	1.84	3.3856	1.35647	4.28952	2.44	5.9536	1.56205	4.93964
1.25	1.5625	1.11803	3.53553	**1.85**	3.4225	1.36015	4.30116	**2.45**	6.0025	1.56525	4.94975
1.26	1.5876	1.12250	3.54965	1.86	3.4596	1.36382	4.31277	2.46	6.0516	1.56844	4.95984
1.27	1.6129	1.12694	3.56371	1.87	3.4969	1.36748	4.32435	2.47	6.1009	1.57162	4.96991
1.28	1.6384	1.13137	3.57771	1.88	3.5344	1.37113	4.33590	2.48	6.1504	1.57480	4.97996
1.29	1.6641	1.13578	3.59166	1.89	3.5721	1.37477	4.34741	2.49	6.2001	1.57797	4.98999
1.30	1.6900	1.14018	3.60555	**1.90**	3.6100	1.37840	4.35890	**2.50**	6.2500	1.58114	5.00000
1.31	1.7161	1.14455	3.61939	1.91	3.6481	1.38203	4.37035	2.51	6.3001	1.58430	5.00999
1.32	1.7424	1.14891	3.63318	1.92	3.6864	1.38564	4.38178	2.52	6.3504	1.58745	5.01996
1.33	1.7689	1.15326	3.64692	1.93	3.7249	1.38924	4.39318	2.53	6.4009	1.59060	5.02991
1.34	1.7956	1.15758	3.66060	1.94	3.7636	1.39284	4.40454	2.54	6.4516	1.59374	5.03984
1.35	1.8225	1.16190	3.67423	**1.95**	3.8025	1.39642	4.41588	**2.55**	6.5025	1.59687	5.04975
1.36	1.8496	1.16619	3.68782	1.96	3.8416	1.40000	4.42719	2.56	6.5536	1.60000	5.05964
1.37	1.8769	1.17047	3.70135	1.97	3.8809	1.40357	4.43847	2.57	6.6049	1.60312	5.06952
1.38	1.9044	1.17473	3.71484	1.98	3.9204	1.40712	4.44972	2.58	6.6564	1.60624	5.07937
1.39	1.9321	1.17898	3.72827	1.99	3.9601	1.41067	4.46094	2.59	6.7081	1.60935	5.08920
1.40	1.9600	1.18322	3.74166	**2.00**	4.0000	1.41421	4.47214	**2.60**	6.7600	1.61245	5.09902
1.41	1.9881	1.18743	3.75500	2.01	4.0401	1.41774	4.48330	2.61	6.8121	1.61555	5.10882
1.42	2.0164	1.19164	3.76829	2.02	4.0804	1.42127	4.49444	2.62	6.8644	1.61864	5.11859
1.43	2.0449	1.19583	3.78153	2.03	4.1209	1.42478	4.50555	2.63	6.9169	1.62173	5.12835
1.44	2.0736	1.20000	3.79473	2.04	4.1616	1.42829	4.51664	2.64	6.9696	1.62481	5.13809
1.45	2.1025	1.20416	3.80789	**2.05**	4.2025	1.43178	4.52769	**2.65**	7.0225	1.62788	5.14782
1.46	2.1316	1.20830	3.82099	2.06	4.2436	1.43527	4.53872	2.66	7.0756	1.63095	5.15752
1.47	2.1609	1.21244	3.83406	2.07	4.2849	1.43875	4.54973	2.67	7.1289	1.63401	5.16720
1.48	2.1904	1.21655	3.84708	2.08	4.3264	1.44222	4.56070	2.68	7.1824	1.63707	5.17687
1.49	2.2201	1.22066	3.86005	2.09	4.3681	1.44568	4.57165	2.69	7.2361	1.64012	5.18652
1.50	2.2500	1.22474	3.87298	**2.10**	4.4100	1.44914	4.58258	**2.70**	7.2900	1.64317	5.19615
1.51	2.2801	1.22882	3.88587	2.11	4.4521	1.45258	4.59347	2.71	7.3441	1.64621	5.20577
1.52	2.3104	1.23288	3.89872	2.12	4.4944	1.45602	4.60435	2.72	7.3984	1.64924	5.21536
1.53	2.3409	1.23693	3.91152	2.13	4.5369	1.45945	4.61519	2.73	7.4529	1.65227	5.22494
1.54	2.3716	1.24097	3.92428	2.14	4.5796	1.46287	4.62601	2.74	7.5076	1.65529	5.23450
1.55	2.4025	1.24499	3.93700	**2.15**	4.6225	1.46629	4.63681	**2.75**	7.5625	1.65831	5.24404
1.56	2.4336	1.24900	3.94968	2.16	4.6656	1.46969	4.64758	2.76	7.6176	1.36132	5.25357
1.57	2.4649	1.25300	3.96232	2.17	4.7089	1.47309	4.65833	2.77	7.6729	1.66433	5.26308
1.58	2.4964	1.25698	3.97492	2.18	4.7524	1.47648	4.66905	2.78	7.7284	1.66733	5.27257
1.59	2.5281	1.26095	3.98748	2.19	4.7961	1.47986	4.67974	2.79	7.7841	1.67033	5.28205
1.60	2.5600	1.26491	4.00000	**2.20**	4.8400	1.48324	4.69042	**2.80**	7.8400	1.67332	5.29150
N	N^2	$\sqrt{N}$	$\sqrt{10N}$	N	N^2	$\sqrt{N}$	$\sqrt{10N}$	N	N^2	$\sqrt{N}$	$\sqrt{10N}$

SQUARES AND SQUARE ROOTS

(continued)

N	N^2	$\sqrt{N}$	$\sqrt{10N}$	N	N^2	$\sqrt{N}$	$\sqrt{10N}$	N	N^2	$\sqrt{N}$	$\sqrt{10N}$
2.80	7.8400	1.67332	5.29150	**3.40**	11.5600	1.84391	5.83095	**4.00**	16.0000	2.00000	6.32456
2.81	7.8961	1.67631	5.30094	3.41	11.6281	1.84662	5.83952	4.01	16.0801	2.00250	6.33246
2.82	7.9524	1.67929	5.31037	3.42	11.6964	1.84932	5.84808	4.02	16.1604	2.00499	6.34035
2.83	8.0089	1.68226	5.31977	3.43	11.7649	1.85203	5.85662	4.03	16.2409	2.00749	6.34823
2.84	8.0656	1.68523	5.32917	3.44	11.8336	1.85472	5.86515	4.04	16.3216	2.00998	6.35610
2.85	8.1225	1.68819	5.33854	**3.45**	11.9025	1.85742	5.87367	**4.05**	16.4025	2.01246	6.36396
2.86	8.1796	1.69115	5.34790	3.46	11.9716	1.86011	5.88218	4.06	16.4836	2.01494	6.37181
2.87	8.2369	1.69411	5.35724	3.47	12.0409	1.86279	5.89067	4.07	16.5649	2.01742	6.37966
2.88	8.2944	1.69706	5.36656	3.48	12.1104	1.86548	5.89915	4.08	16.6464	2.01990	6.38749
2.89	8.3521	1.70000	5.37587	3.49	12.1801	1.86815	5.90762	4.09	16.7281	2.02237	6.39531
2.90	8.4100	1.70294	5.38516	**3.50**	12.2500	1.87083	5.91608	**4.10**	16.8100	2.02485	6.40312
2.91	8.4681	1.70587	5.39444	3.51	12.3201	1.87350	5.92453	4.11	16.8921	2.02731	6.41093
2.92	8.5264	1.70880	5.40370	3.52	12.3904	1.87617	5.93296	4.12	16.9744	2.02978	6.41872
2.93	8.5849	1.71172	5.41295	3.53	12.4609	1.87883	5.94138	4.13	17.0569	2.03224	6.42651
2.94	8.6436	1.71464	5.42218	3.54	12.5316	1.88149	5.94979	4.14	17.1396	2.03470	6.43428
2.95	8.7025	1.71756	5.43139	**3.55**	12.6025	1.88414	5.95819	**4.15**	17.2225	2.03715	6.44205
2.96	8.7616	1.72047	5.44059	3.56	12.6736	1.88680	5.96657	4.16	17.3056	2.03961	6.44981
2.97	8.8209	1.72337	5.44977	3.57	12.7449	1.88944	5.97495	4.17	17.3889	2.04206	6.45755
2.98	8.8804	1.72627	5.45894	3.58	12.8164	1.89209	5.98331	4.18	17.4724	2.04450	6.46529
2.99	8.9401	1.72916	5.46809	3.59	12.8881	1.89473	5.99166	4.19	17.5561	2.04695	6.47302
3.00	9.0000	1.73205	5.47723	**3.60**	12.9600	1.89737	6.00000	**4.20**	17.6400	2.04939	6.48074
3.01	9.0601	1.73494	5.48635	3.61	13.0321	1.90000	6.00833	4.21	17.7241	2.05183	6.48845
3.02	9.1204	1.73781	5.49545	3.62	13.1044	1.90263	6.01664	4.22	17.8084	2.05426	6.49615
3.03	9.1809	1.74069	5.50454	3.63	13.1769	1.90526	6.02495	4.23	17.8929	2.05670	6.50384
3.04	9.2416	1.74356	5.51362	3.64	13.2496	1.90788	6.03324	4.24	17.9776	2.05913	6.51153
3.05	9.3025	1.74642	5.52268	**3.65**	13.3225	1.91050	6.04152	**4.25**	18.0625	2.06155	6.51920
3.06	9.3636	1.74929	5.53173	3.66	13.3956	1.91311	6.04979	4.26	18.1476	2.06398	6.52687
3.07	9.4249	1.75214	5.54076	3.67	13.4689	1.91572	6.05805	4.27	18.2329	2.06640	6.53452
3.08	9.4864	1.75499	5.54977	3.68	13.5424	1.91833	6.06630	4.28	18.3184	2.06882	6.54217
3.09	9.5481	1.75784	5.55878	3.69	13.6161	1.92094	6.07454	4.29	18.4041	2.07123	6.54981
3.10	9.6100	1.76068	5.56776	**3.70**	13.6900	1.92354	6.08276	**4.30**	18.4900	2.07364	6.55744
3.11	9.6721	1.76352	5.57674	3.71	13.7641	1.92614	6.09098	4.31	18.5761	2.07605	6.56506
3.12	9.7344	1.76635	5.58570	3.72	13.8384	1.92873	6.09918	4.32	18.6624	2.07846	6.57267
3.13	9.7969	1.76918	5.59464	3.73	13.9129	1.93132	6.10737	4.33	18.7489	2.08087	6.58027
3.14	9.8596	1.77200	5.60357	3.74	13.9876	1.93391	6.11555	4.34	18.8356	2.08327	6.58787
3.15	9.9225	1.77482	5.61249	**3.75**	14.0625	1.93649	6.12372	**4.35**	18.9225	2.08567	6.59545
3.16	9.9856	1.77764	5.62139	3.76	14.1376	1.93907	6.13188	4.36	19.0096	2.08806	6.60303
3.17	10.0489	1.78045	5.63028	3.77	14.2129	1.94165	6.14003	4.37	19.0969	2.09045	6.61060
3.18	10.1124	1.78326	5.63915	3.78	14.2884	1.94422	6.14817	4.38	19.1844	2.09284	6.61816
8.19	10.1761	1.78606	5.64801	3.79	14.3641	1.94679	6.15630	4.39	19.2721	2.09523	6.62571
3.20	10.2400	1.78885	5.65685	**3.80**	14.4400	1.94936	6.16441	**4.40**	19.3600	2.09762	6.63325
3.21	10.3041	1.79165	5.66569	3.81	14.5161	1.95192	6.17252	4.41	19.4481	2.10000	6.64078
3.22	10.3684	1.79444	5.67450	3.82	14.5924	1.95448	6.18061	4.42	19.5364	2.10238	6.64831
3.23	10.4329	1.79722	5.68331	3.83	14.6689	1.95704	6.18870	4.43	19.6249	2.10476	6.65582
3.24	10.4976	1.80000	5.69210	3.84	14.7456	1.95959	6.19677	4.44	19.7136	2.10713	6.66333
3.25	10.5625	1.80278	5.70088	**3.85**	14.8225	1.96214	6.20484	**4.45**	19.8025	2.10950	6.67083
3.26	10.6276	1.80555	5.70964	3.86	14.8996	1.96469	6.21289	4.46	19.8916	2.11187	6.67832
3.27	10.6929	1.80331	5.71839	3.87	14.9769	1.96723	6.22093	4.47	19.9809	2.11424	6.68581
3.28	10.7584	1.81108	5.72713	3.88	15.0544	1.96977	6.22896	4.48	20.0704	2.11660	6.69328
3.29	10.8241	1.81384	5.73585	3.89	15.1321	1.97231	6.23699	4.49	20.1601	2.11896	6.70075
3.30	10.8900	1.81659	5.74456	**3.90**	15.2100	1.97484	6.24500	**4.50**	20.2500	2.12132	6.70820
3.31	10.9561	1.81934	5.75326	3.91	15.2881	1.97737	6.25300	4.51	20.3401	2.12368	6.71565
3.32	11.0224	1.82209	5.76194	3.92	15.3664	1.97990	6.26099	4.52	20.4304	2.12603	6.72309
3.33	11.0889	1.82483	5.77062	3.93	15.4449	1.98242	6.26897	4.53	20.5209	2.12838	6.73053
3.34	11.1556	1.82757	5.77927	3.94	15.5236	1.98494	6.27694	4.54	20.6116	2.13073	6.73795
3.35	11.2225	1.83030	5.78792	**3.95**	15.6025	1.98746	6.28490	**4.55**	20.7025	2.13307	6.74537
3.36	11.2896	1.83303	5.79655	3.96	15.6816	1.98997	6.29285	4.56	20.7936	2.13542	6.75278
3.37	11 3569	1.83576	5.80517	3.97	15.7609	1.99249	6.30079	4.57	20.8849	2.13776	6.76018
3.38	11.4244	1.83848	5.81378	3.98	15.8404	1.99499	6.30872	4.58	20.9764	2.14009	6.76757
3.39	11.4921	1.84120	5.82237	3.99	15.9201	1.99750	6.31664	4.59	21.0681	2.14243	6.77495
3.40	11.5600	1.84391	5.83095	**4.00**	16.0000	2.00000	6.32456	**4.60**	21.1600	2.14476	6.78233
N	N^2	$\sqrt{N}$	$\sqrt{10N}$	N	N^2	$\sqrt{N}$	$\sqrt{10N}$	N	N^2	$\sqrt{N}$	$\sqrt{10N}$

SQUARES AND SQUARE ROOTS
(continued)

N	N^2	$\sqrt{N}$	$\sqrt{10N}$	N	N^2	$\sqrt{N}$	$\sqrt{10N}$	N	N^2	$\sqrt{N}$	$\sqrt{10N}$
4.60	21.1600	2.14476	6.78233	**5.20**	27.0400	2.28035	7.21110	**5.80**	33.6400	2.40832	7.61577
4.61	21.2521	2.14709	6.78970	5.21	27.1441	2.28254	7.21803	5.81	33.7561	2.41039	7.62234
4.62	21.3444	2.14942	6.79706	5.22	27.2484	2.28473	7.22496	5.82	33.8724	2.41247	7.62889
4.63	21.4369	2.15174	6.80441	5.23	27.3529	2.28692	7.23187	5.83	33.9889	2.41454	7.63544
4.64	21.5296	2.15407	6.81175	5.24	27.4576	2.28910	7.23878	5.84	34.1056	2.41661	7.64199
4.65	21.6225	2.15639	6.81909	**5.25**	27.5625	2.29129	7.24569	**5.85**	34.2225	2.41868	7.64853
4.66	21.7156	2.15870	6.82642	5.26	27.6676	2.29347	7.25259	5.86	34.3396	2.42074	7.65506
4.67	21.8089	2.16102	6.83374	5.27	27.7729	2.29565	7.25948	5.87	34.4569	2.42281	7.66159
4.68	21.9024	2.16333	6.84105	5.28	27.8784	2.29783	7.26636	5.88	34.5744	2.42487	7.66812
4.69	21.9961	2.16564	6.84836	5.29	27.9841	2.30000	7.27324	5.89	34.6921	2.42693	7.67463
4.70	22.0900	2.16795	6.85565	**5.30**	28.0900	2.30217	7.28011	**5.90**	34.8100	2.42899	7.68115
4.71	22.1841	2.17025	6.86294	5.31	28.1961	2.30434	7.28697	5.91	34.9281	2.43105	7.68765
4.72	22.2784	2.17256	6.87023	5.32	28.3024	2.30651	7.29383	5.92	35.0464	2.43311	7.69415
4.73	22.3729	2.17486	6.87750	5.33	28.4089	2.30868	7.30068	5.93	35.1649	2.43516	7.70065
4.74	22.4676	2.17715	6.88477	5.34	28.5156	2.31084	7.30753	5.94	35.2836	2.43721	7.70714
4.75	22.5625	2.17945	6.89202	**5.35**	28.6225	2.31301	7.31437	**5.95**	35.4025	2.43926	7.71362
4.76	22.6576	2.18174	6.89928	5.36	28.7296	2.31517	7.32120	5.96	35.5216	2.44131	7.72010
4.77	22.7529	2.18403	6.90652	5.37	28.8369	2.31733	7.32803	5.97	35.6409	2.44336	7.72658
4.78	22.8484	2.18632	6.91375	5.38	28.9444	2.31948	7.33485	5.98	35.7604	2.44540	7.73305
4.79	22.9441	2.18861	6.92098	5.39	29.0521	2.32164	7.34166	5.99	35.8801	2.44745	7.73951
4.80	23.0400	2.19089	6.92820	**5.40**	29.1600	2.32379	7.34847	**6.00**	36.0000	2.44949	7.74597
4.81	23.1361	2.19317	6.93542	5.41	29.2681	2.32594	7.35527	6.01	36.1201	2.45153	7.75242
4.82	23.2324	2.19545	6.94262	5.42	29.3764	2.32809	7.36206	6.02	36.2404	2.45357	7.75887
4.83	23.3289	2.19773	6.94982	5.43	29.4849	2.33024	7.36885	6.03	36.3609	2.45561	7.76531
4.84	23.4256	2.20000	6.95701	5.44	29.5936	2.33238	7.37564	6.04	36.4816	2.45764	7.77174
4.85	23.5225	2.20227	6.96419	**5.45**	29.7025	2.33452	7.38241	**6.05**	36.6025	2.45967	7.77817
4.86	23.6196	2.20454	6.97137	5.46	29.8116	2.33666	7.38918	6.06	36.7236	2.46171	7.78460
4.87	23.7169	2.20681	6.97854	5.47	29.9209	2.33880	7.39594	6.07	36.8449	2.46374	7.79102
4.88	23.8144	2.20907	6.98570	5.48	30.0304	2.34094	7.40270	6.08	36.9664	2.46577	7.79744
4.89	23.9121	2.21133	6.99285	5.49	30.1401	2.34307	7.40945	6.09	37.0881	2.46779	7.80385
4.90	24.0100	2.21359	7.00000	**5.50**	30.2500	2.34521	7.41620	**6.10**	37.2100	2.46982	7.81025
4.91	24.1081	2.21585	7.00714	5.51	30.3601	2.34734	7.42294	6.11	37.3321	2.47184	7.81665
4.92	24.2064	2.21811	7.01427	5.52	30.4704	2.34947	7.42967	6.12	37.4544	2.47386	7.82304
4.93	24.3049	2.22036	7.02140	5.53	30.5809	2.35160	7.43640	6.13	37.5769	2.47588	7.82943
4.94	24.4036	2.22261	7.02851	5.54	30.6916	2.35372	7.44312	6.14	37.6996	2.47790	7.83582
4.95	24.5025	2.22486	7.03562	**5.55**	30.8025	2.35584	7.44933	**6.15**	37.8225	2.47992	7.84219
4.96	24.6016	2.22711	7.04273	5.53	30.9136	2.35797	7.45654	6.16	37.9456	2.48193	7.84857
4.97	24.7009	2.22935	7.04982	5.57	31.0249	2.36008	7.46324	6.17	38.0689	2.48395	7.85493
4.98	24.8004	2.23159	7.05691	5.58	31.1364	2.36220	7.46994	6.18	38.1924	2.48596	7.86130
4.99	24.9001	2.23383	7.06399	5.59	31.2481	2.36432	7.47663	6.19	38.3161	2.48797	7.86766
5.00	25.0000	2.23607	7.07107	**5.60**	31.3600	2.36643	7.48331	**6.20**	38.4400	2.48998	7.87401
5.01	25.1001	2.23830	7.07814	5.61	31.4721	2.36854	7.48999	6.21	38.5641	2.49199	7.88036
5.02	25.2004	2.24054	7.08520	5.62	31.5844	2.37065	7.49667	6.22	38.6884	2.49399	7.88670
5.03	25.3009	2.24277	7.09225	5.63	31.6969	2.37276	7.50333	6.23	38.8129	2.49600	7.89303
5.04	25.4016	2.24499	7.09930	5.64	31.8096	2.37487	7.50999	6.24	38.9376	2.49800	7.89937
5.05	25.5025	2.24722	7.10634	**5.65**	31.9225	2.37697	7.51665	**6.25**	39.0625	2.50000	7.90569
5.06	25.6036	2.24944	7.11337	5.66	32.0356	2.37908	7.52330	6.26	39.1876	2.50200	7.91202
5.07	25.7049	2.25167	7.12039	5.67	32.1489	2.38118	7.52994	6.27	39.3129	2.50400	7.91833
5.08	25.8064	2.25389	7.12741	5.68	32.2624	2.38328	7.53658	6.28	39.4384	2.50599	7.92465
5.09	25.9081	2.25610	7.13442	5.69	32.3761	2.38537	7.54321	6.29	39.5641	2.50799	7.93095
5.10	26.0100	2.25832	7.14143	**5.70**	32.4900	2.38747	7.54983	**6.30**	39.6900	2.50998	7.93725
5.11	26.1121	2.26053	7.14843	5.71	32.6041	2.38956	7.55645	6.31	39.8161	2.51197	7.94355
5.12	26.2144	2.26274	7.15542	5.72	32.7184	2.39165	7.56307	6.32	39.9424	2.51396	7.94984
5.13	26.3169	2.26495	7.16240	5.73	32.8329	2.39374	7.56968	6.33	40.0689	2.51595	7.95613
5.14	26.4196	2.26716	7.16938	5.74	32.9476	2.39583	7.57628	6.34	40.1956	2.51794	7.96241
5.15	26.5225	2.26936	7.17635	**5.75**	33.0625	2.39792	7.58288	**6.35**	40.3225	2.51992	7.96869
5.16	26.6256	2.27156	7.18331	5.76	33.1776	2.40000	7.58947	6.36	40.4496	2.52190	7.97496
5.17	26.7289	2.27376	7.19027	5.77	33.2929	2.40208	7.59605	6.37	40.5769	2.52389	7.98123
5.18	26.8324	2.27596	7.19722	5.78	33.4084	2.40416	7.60263	6.38	40.7044	2.52587	7.98749
5.19	26.9361	2.27816	7.20417	5.79	33.5241	2.40624	7.60920	6.39	40.8321	2.52784	7.99375
5.20	27.0400	2.28035	7.21110	**5.80**	33.6400	2.40832	7.61577	**6.40**	40.9600	2.52982	8.00000
N	N^2	$\sqrt{N}$	$\sqrt{10N}$	N	N^2	$\sqrt{N}$	$\sqrt{10N}$	N	N^2	$\sqrt{N}$	$\sqrt{10N}$

SQUARES AND SQUARE ROOTS

(continued)

N	N^2	$\sqrt{N}$	$\sqrt{10N}$	N	N^2	$\sqrt{N}$	$\sqrt{10N}$	N	N^2	$\sqrt{N}$	$\sqrt{10N}$
6.40	40.9600	2.52982	8.00000	**7.00**	49.0000	2.64575	8.36660	**7.60**	57.7600	2.75681	8.71780
6.41	41.0881	2.53180	8.00625	7.01	49.1401	2.64764	8.37257	7.61	57.9121	2.75862	8.72353
6.42	41.2164	2.53377	8.01249	7.02	49.2804	2.64953	8.37854	7.62	58.0644	2.76043	8.72926
6.43	41.3449	2.53574	8.01873	7.03	49.4209	2.65141	8.38451	7.63	58.2169	2.76225	8.73499
6.44	41.4736	2.53772	8.02496	7.04	49.5616	2.65330	8.39047	7.64	58.3696	2.76405	8.74071
6.45	41.6025	2.53969	8.03119	**7.05**	49.7025	2.65518	8.39643	**7.65**	58.5225	2.76586	8.74643
6.46	41.7316	2.54165	8.03741	7.06	49.8436	2.65707	8.40238	7.66	58.6756	2.76767	8.75214
6.47	41.8609	2.54362	8.04363	7.07	49.9849	2.65895	8.40833	7.67	58.8289	2.76948	8.75785
6.48	41.9904	2.54558	8.04984	7.08	50.1264	2.66083	8.41427	7.68	58.9824	2.77128	8.76356
6.49	42.1201	2.54755	8.05605	7.09	50.2681	2.66271	8.42021	7.69	59.1361	2.77308	8.76926
6.50	42.2500	2.54951	8.06226	**7.10**	50.4100	2.66458	8.42615	**7.70**	59.2900	2.77489	8.77496
6.51	42.3801	2.55147	8.06846	7.11	50.5521	2.66646	8.43208	7.71	59.4441	2.77669	8.78066
6.52	42.5104	2.55343	8.07465	7.12	50.6944	2.66833	8.43801	7.72	59.5984	2.77849	8.78635
6.53	42.6409	2.55539	8.08084	7.13	50.8369	2.67021	8.44393	7.73	59.7529	2.78029	8.79204
6.54	42.7716	2.55734	8.08703	7.14	50.9796	2.67208	8.44985	7.74	59.9076	2.78209	8.79773
6.55	42.9025	2.55930	8.09321	**7.15**	51.1225	2.67395	8.45577	**7.75**	60.0625	2.78388	8.80341
6.56	43.0336	2.56125	8.09938	7.16	51.2656	2.67582	8.46168	7.76	60.2176	2.78568	8.80909
6.57	43.1649	2.56320	8.10555	7.17	51.4089	2.67769	8.46759	7.77	60.3729	2.78747	8.81476
6.58	43.2964	2.56515	8.11172	7.18	51.5524	2.67955	8.47349	7.78	60.5284	2.78927	8.82043
6.59	43.4281	2.56710	8.11788	7.19	51.6961	2.68142	8.47939	7.79	60.6841	2.79106	8.82610
6.60	43.5600	2.56905	8.12404	**7.20**	51.8400	2.68328	8.48528	**7.80**	60.8400	2.79285	8.83176
6.61	43.6921	2.57099	8.13019	7.21	51.9841	2.68514	8.49117	7.81	60.9961	2.79464	8.83742
6.62	43.8244	2.57294	8.13634	7.22	52.1284	2.68701	8.49706	7.82	61.1524	2.79643	8.84308
6.63	43.9569	2.57488	8.14248	7.23	52.2729	2.68887	8.50294	7.83	61.3089	2.79821	8.84873
6.64	44.0896	2.57682	8.14862	7.24	52.4176	2.69072	8.50882	7.84	61.4656	2.80000	8.85438
6.65	44.2225	2.57876	8.15475	**7.25**	52.5625	2.69258	8.51469	**7.85**	61.6225	2.80179	8.86002
6.66	44.3556	2.58070	8.16088	7.26	52.7076	2.69444	8.52056	7.86	61.7796	2.80357	8.86566
6.67	44.4889	2.58263	8.16701	7.27	52.8529	2.69629	8.52643	7.87	61.9369	2.80535	8.87130
6.68	44.6224	2.58457	8.17313	7.28	52.9984	2.69815	8.53229	7.88	62.0944	2.80713	8.87694
6.69	44.7561	2.58650	8.17924	7.29	53.1441	2.70000	8.63815	7.89	62.2521	2.80891	8.88257
6.70	44.8900	2.58844	8.18535	**7.30**	53.2900	2.70185	8.54400	**7.90**	62.4100	2.81069	8.88819
6.71	45.0241	2.59037	8.19146	7.31	53.4361	2.70370	8.54985	7.91	62.5681	2.81247	8.89382
6.72	45.1584	2.59230	8.19756	7.32	53.5824	2.70555	8.55570	7.92	62.7264	2.81425	8.89944
6.73	45.2929	2.59422	8.20366	7.33	53.7289	2.70740	8.56154	7.93	62.8849	2.81603	8.90505
6.74	45.4276	2.59615	8.20975	7.34	53.8756	2.70924	8.56738	7.94	63.0436	2.81780	8.91067
6.75	45.5625	2.59808	8.21584	**7.35**	54.0225	2.71109	8.57321	**7.95**	63.2025	2.81957	8.91628
6.76	45.6976	2.60000	8.22192	7.36	54.1696	2.71293	8.57904	7.96	63.3616	2.82135	8.92188
6.77	45.8329	2.60192	8.22800	7.37	54.3169	2.71477	8.58487	7.97	63.5209	2.82312	8.92749
6.78	45.9684	2.60384	8.23408	7.38	54.4644	2.71662	8.59069	7.98	63.6804	2.82489	8.93308
6.79	46.1041	2.60576	8.24015	7.39	54.6121	2.71846	8.59651	7.99	63.8401	2.82666	8.93868
6.80	46.2400	2.60768	8.24621	**7.40**	54.7600	2.72029	8.60233	**8.00**	64.0000	2.82843	8.94427
6.81	46.3761	2.60960	8.25227	7.41	54.9081	2.72213	8.60814	8.01	64.1601	2.83019	8.94986
6.82	46.5124	2.61151	8.25833	7.42	55.0564	2.72397	8.61394	8.02	64.3204	2.83196	8.95545
6.83	46.6489	2.61343	8.26438	7.43	55.2049	2.72580	8.61974	8.03	64.4809	2.83373	8.96103
6.84	46.7856	2.61534	8.27043	7.44	55.3536	2.72764	8.62554	8.04	64.6416	2.83549	8.96660
6.85	46.9225	2.61725	8.27647	**7.45**	55.5025	2.72947	8.63134	**8.05**	64.8025	2.83725	8.97218
6.86	47.0596	2.61916	8.28251	7.46	55.6516	2.73130	8.63713	8.06	64.9636	2.83901	8.97775
6.87	47.1969	2.62107	8.28855	7.47	55.8009	2.73313	8.64292	8.07	65.1249	2.84077	8.98332
6.88	47.3344	2.62298	8.29458	7.48	55.9504	2.73496	8.64870	8.08	65.2864	2.84253	8.98888
6.89	47.4721	2.62488	8.30060	7.49	56.1001	2.73679	8.65448	8.09	65.4481	2.84429	8.99444
6.90	47.6100	2.62679	8.30662	**7.50**	56.2500	2.73861	8.66025	**8.10**	65.6100	2.84605	9.00000
6.91	47.7481	2.62869	8.31264	7.51	56.4001	2.74044	8.66603	8.11	65.7721	2.84781	9.00555
6.92	47.8864	2.63059	8.31865	7.52	56.5504	2.74226	8.67179	8.12	65.9344	2.84956	9.01110
6.93	48.0249	2.63249	8.32466	7.53	56.7009	2.74408	8.67756	8.13	66.0969	2.85132	9.01665
6.94	48.1636	2.63439	8.33067	7.54	56.8516	2.74591	8.68332	8.14	66.2596	2.85307	9.02219
6.95	48.3025	2.63629	8.33667	**7.55**	57.0025	2.74773	8.68907	**8.15**	66.4225	2.85482	9.02774
6.96	48.4416	2.63818	8.34266	7.56	57.1536	2.74955	8.69483	8.16	66.5856	2.85657	9.03327
6.97	48.5809	2.64008	8.34865	7.57	57.3049	2.75136	8.70057	8.17	66.7489	2.85832	9.03881
6.98	48.7204	2.64197	8.35464	7.58	57.4564	2.75318	8.70632	8.18	66.9124	2.86007	9.04434
6.99	48.8601	2.64386	8.36062	7.59	57.6081	2.75500	8.71206	8.19	67.0761	2.86182	9.04986
7.00	49.0000	2.64575	8.36660	**7.60**	57.7600	2.75681	8.71780	**8.20**	67.2400	2.86356	9.05539
N	N^2	$\sqrt{N}$	$\sqrt{10N}$	N	N^2	$\sqrt{N}$	$\sqrt{10N}$	N	N^2	$\sqrt{N}$	$\sqrt{10N}$

SQUARES AND SQUARE ROOTS
(continued)

N	N^2	$\sqrt{N}$	$\sqrt{10N}$	N	N^2	$\sqrt{N}$	$\sqrt{10N}$	N	N^2	$\sqrt{N}$	$\sqrt{10N}$
8.20	67.2400	2.86356	9.05539	**8.80**	77.4400	2.96648	9.38083	**9.40**	88.3600	3.06594	9.69536
8.21	67.4041	2.86531	9.06091	8.81	77.6161	2.96816	9.38616	9.41	88.5481	3.06757	9.70052
8.22	67.5684	2.86705	9.06642	8.82	77.7924	2.96985	9.39149	9.42	88.7364	3.06920	9.70567
8.23	67.7329	2.86880	9.07193	8.83	77.9689	2.97153	9.39681	9.43	88.9249	3.07083	9.71082
8.24	67.8976	2.87054	9.07744	8.84	78.1456	2.97321	9.40213	9.44	89.1136	3.07246	9.71597
8.25	68.0625	2.87228	9.08295	**8.85**	78.3225	2.97489	9.40744	**9.45**	89.3025	3.07409	9.72111
8.26	68.2276	2.87402	9.08845	8.86	78.4996	2.97658	9.41276	9.46	89.4916	3.07571	9.72625
8.27	68.3929	2.87576	9.09395	8.87	78.6769	2.97825	9.41807	9.47	89.6809	3.07734	9.73139
8.28	68.5584	2.87750	9.09945	8.88	78.8544	2.97993	9.42338	9.48	89.8704	3.07896	9.73653
8.29	68.7241	2.87924	9.10494	8.89	79.0321	2.98161	9.42868	9.49	90.0601	3.08058	9.74166
8.30	68.8900	2.88097	9.11043	**8.90**	79.2100	2.98329	9.43398	**9.50**	90.2500	3.08221	9.74679
8.31	69.0561	2.88271	9.11592	8.91	79.3881	2.98496	9.43928	9.51	90.4401	3.08383	9.75192
8.32	69.2224	2.88444	9.12140	8.92	79.5664	2.98664	9.44458	9.52	90.6304	3.08545	9.75705
8.33	69.3889	2.88617	9.12688	8.93	79.7449	2.98831	9.44987	9.53	90.8209	3.08707	9.76217
8.34	69.5556	2.88791	9.13236	8.94	79.9236	2.98998	9.45516	9.54	91.0116	3.08869	9.76729
8.35	69.7225	2.88964	9.13783	**8.95**	80.1025	2.99166	9.46044	**9.55**	91.2025	3.09031	9.77241
8.36	69.8896	2.89137	9.14330	8.96	80.2816	2.99333	9.46573	9.56	91.3936	3.09192	9.77753
8.37	70.0569	2.89310	9.14877	8.97	80.4609	2.99500	9.47101	9.57	91.5849	3.09354	9.78264
8.38	70.2244	2.89482	9.15423	8.98	80.6404	2.99666	9.47629	9.58	91.7764	3.09516	9.78775
8.39	70.3921	2.89655	9.15969	8.99	80.8201	2.99833	9.48156	9.59	91.9681	3.09677	9.79285
8.40	70.5600	2.89828	9.16515	**9.00**	81.0000	3.00000	9.48683	**9.60**	92.1600	3.09839	9.79796
8.41	70.7281	2.90000	9.17061	9.01	81.1801	3.00167	9.49210	9.61	92.3521	3.10000	9.80306
8.42	70.8964	2.90172	9.17606	9.02	81.3604	3.00333	9.49737	9.62	92.5444	3.10161	9.80816
8.43	71.0649	2.90345	9.18150	9.03	81.5409	3.00500	9.50263	9.63	92.7369	3.10322	9.81326
8.44	71.2336	2.90517	9.18695	9.04	81.7216	3.00666	9.50789	9.64	92.9296	3.10483	9.81835
8.45	71.4025	2.90689	9.19239	**9.05**	81.9025	3.00832	9.51315	**9.65**	93.1225	3.10644	9.82344
8.46	71.5716	2.90861	9.19783	9.06	82.0836	3.00998	9.51840	9.66	93.3156	3.10805	9.82853
8.47	71.7409	2.91033	9.20326	9.07	82.2649	3.01164	9.52365	9.67	93.5089	3.10966	9.83362
8.48	71.9104	2.91204	9.20869	9.08	82.4464	3.01330	9.52890	9.68	93.7024	3.11127	9.83870
8.49	72.0801	2.91376	9.21412	9.09	82.6281	3.01496	9.53415	9.69	93.8961	3.11288	9.84378
8.50	72.2500	2.91548	9.21954	**9.10**	82.8100	3.01662	9.53939	**9.70**	94.0900	3.11448	9.84886
8.51	72.4201	2.91719	9.22497	9.11	82.9921	3.01828	9.54463	9.71	94.2841	3.11609	9.85393
8.52	72.5904	2.91890	9.23038	9.12	83.1744	3.01993	9.54987	9.72	94.4784	3.11769	9.85901
8.53	72.7609	2.92062	9.23580	9.13	83.3569	3.02159	9.55510	9.73	94.6729	3.11929	9.86408
8.54	72.9316	2.92233	9.24121	9.14	83.5396	3.02324	9.56033	9.74	94.8676	3.12090	9.86914
8.55	73.1025	2.92404	9.24662	**9.15**	83.7225	3.02490	9.56556	**9.75**	95.0625	3.12250	9.87421
8.56	73.2736	2.92575	9.25203	9.16	83.9056	3.02655	9.57079	9.76	95.2576	3.12410	9.87927
8.57	73.4449	2.92746	9.25743	9.17	84.0889	3.02820	9.57601	9.77	95.4529	3.12570	9.88433
8.58	73.6164	2.92916	9.26283	9.18	84.2724	3.02985	9.58123	9.78	95.6484	3.12730	9.88939
8.59	73.7881	2.93087	9.26823	9.19	84.4561	3.03150	9.58645	9.79	95.8441	3.12890	9.89444
8.60	73.9600	2.93258	9.27362	**9.20**	84.6400	3.03315	9.59166	**9.80**	96.0400	3.13050	9.89949
8.61	74.1321	2.93428	9.27901	9.21	84.8241	3.03480	9.59687	9.81	96.2361	3.13209	9.90454
8.62	74.3044	2.93598	9.28440	9.22	85.0084	3.03645	9.60208	9.82	96.4324	3.13369	9.90959
8.63	74.4769	2.93769	9.28978	9.23	85.1929	3.03809	9.60729	9.83	96.6289	3.13528	9.91464
8.64	74.6496	2.93939	9.29516	9.24	85.3776	3.03974	9.61249	9.84	96.8256	3.13688	9.91968
8.65	74.8225	2.94109	9.30054	**9.25**	85.5625	3.04138	9.61769	**9.85**	97.0225	3.13847	9.92472
8.66	74.9956	2.94279	9.30591	9.26	85.7476	3.04302	9.62289	9.86	97.2196	3.14006	9.92975
8.67	75.1689	2.94449	9.31128	9.27	85.9329	3.04467	9.62808	9.87	97.4169	3.14166	9.93479
8.68	75.3424	2.94618	9.31665	9.28	86.1184	3.04631	9.63328	9.88	97.6144	3.14325	9.93982
8.69	75.5161	2.94788	9.32202	9.29	86.3041	3.04795	9.63846	9.89	97.8121	3.14484	9.94485
8.70	75.6900	2.94958	9.32738	**9.30**	86.4900	3.04959	9.64365	**9.90**	98.0100	3.14643	9.94987
8.71	75.8641	2.95127	9.33274	9.31	86.6761	3.05123	9.64883	9.91	98.2081	3.14802	9.95490
8.72	76.0384	2.95296	9.33809	9.32	86.8624	3.05287	9.65401	9.92	98.4064	3.14960	9.95992
8.73	76.2129	2.95466	9.34345	9.33	87.0489	3.05450	9.65919	9.93	98.6049	3.15119	9.96494
8.74	76.3876	2.95635	9.34880	9.34	87.2356	3.05614	9.66437	9.94	98.8036	3.15278	9.96995
8.75	76.5625	2.95804	9.35414	**9.35**	87.4225	3.05778	9.66954	**9.95**	99.0025	3.15436	9.97497
8.76	76.7376	2.95973	9.35949	9.36	87.6096	3.05941	9.67471	9.96	99.2016	3.15595	9.97998
8.77	76.9129	2.96142	9.36483	9.37	87.7969	3.06105	9.67988	9.97	99.4009	3.15753	9.98499
8.78	77.0884	2.96311	9.37017	9.38	87.9844	3.06268	9.68504	9.98	99.6004	3.15911	9.98999
8.79	77.2641	2.96479	9.37550	9.39	88.1721	3.06431	9.69020	9.99	99.8001	3.16070	9.99500
8.80	77.4400	2.96648	9.38083	**9.40**	88.3600	3.06594	9.69536	**10.00**	100.000	3.16228	10.0000
N	N^2	$\sqrt{N}$	$\sqrt{10N}$	N	N^2	$\sqrt{N}$	$\sqrt{10N}$	N	N^2	$\sqrt{N}$	$\sqrt{10N}$

LOGARITHMS TO BASE 10

N	0	1	2	3	4	5	6	7	8	9	Proportional Parts								
											1	2	3	4	5	6	7	8	9
10	0000	0043	0086	0128	0170	0212	0253	0294	0334	0374	4	8	12	17	21	25	29	33	37
11	0414	0453	0492	0531	0569	0607	0645	0682	0719	0755	4	8	11	15	19	23	26	30	34
12	0792	0828	0364	0899	0934	0969	1004	1038	1072	1106	3	7	10	14	17	21	24	28	31
13	1139	1173	1206	1239	1271	1303	1335	1367	1399	1430	3	6	10	13	16	19	23	26	29
14	1461	1492	1523	1553	1584	1614	1644	1673	1703	1732	3	6	9	12	15	18	21	24	27
15	1761	1790	1818	1847	1875	1903	1931	1959	1987	2014	3	6	8	11	14	17	20	22	25
16	2041	2068	2095	2122	2148	2175	2201	2227	2253	2279	3	5	8	11	13	16	18	21	24
17	2304	2330	2355	2380	2405	2430	2455	2480	2504	2529	2	5	7	10	12	15	17	20	22
18	2553	2577	2601	2625	2648	2672	2695	2718	2742	2765	2	5	7	9	12	14	16	19	21
19	2788	2810	2833	2856	2878	2900	2923	2945	2967	2989	2	4	7	9	11	13	16	18	20
20	3010	3032	3054	3075	3096	3118	3139	3160	3181	3201	2	4	6	8	11	13	15	17	19
21	3222	3243	3263	3284	3304	3324	3345	3365	3385	3404	2	4	6	8	10	12	14	16	18
22	3424	3444	3464	3483	3502	3522	3541	3560	3579	3598	2	4	6	8	10	12	14	15	17
23	3617	3636	3655	3674	3692	3711	3729	3747	3766	3784	2	4	6	7	9	11	13	15	17
24	3802	3820	3838	3856	3874	3892	3909	3927	3945	3962	2	4	5	7	9	11	12	14	16
25	3979	3997	4014	4031	4048	4065	4082	4099	4116	4133	2	3	5	7	9	10	12	14	15
26	4150	4166	4183	4200	4216	4232	4249	4265	4281	4298	2	3	5	7	8	10	11	13	15
27	4314	4330	4346	4362	4378	4393	4409	4425	4440	4456	2	3	5	6	8	9	11	13	14
28	4472	4487	4502	4518	4533	4548	4564	4579	4594	4609	2	3	5	6	8	9	11	12	14
29	4624	4639	4654	4669	4683	4698	4713	4728	4742	4757	1	3	4	6	7	9	10	12	13
30	4771	4786	4800	4814	4829	4843	4857	4871	4886	4900	1	3	4	6	7	9	10	11	13
31	4914	4928	4942	4955	4969	4983	4997	5011	5024	5038	1	3	4	6	7	8	10	11	12
32	5051	5065	5079	5092	5105	5119	5132	5145	5159	5172	1	3	4	5	7	8	9	11	12
33	5185	5198	5211	5224	5237	5250	5263	5276	5289	5302	1	3	4	5	6	8	9	10	12
34	5315	5328	5340	5353	5366	5378	5391	5403	5416	5428	1	3	4	5	6	8	9	10	11
35	5441	5453	5465	5478	5490	5502	5514	5527	5539	5551	1	2	4	5	6	7	9	10	11
36	5563	5575	5587	5599	5611	5623	5635	5647	5658	5670	1	2	4	5	6	7	8	10	11
37	5682	5694	5705	5717	5729	5740	5752	5763	5775	5786	1	2	3	5	6	7	8	9	10
38	5798	5809	5821	5832	5843	5855	5866	5877	5888	5899	1	2	3	5	6	7	8	9	10
39	5911	5922	5933	5944	5955	5966	5977	5988	5999	6010	1	2	3	4	5	7	8	9	10
40	6021	6031	6042	6053	6064	6075	6085	6096	6107	6117	1	2	3	4	5	6	8	9	10
41	6128	6138	6149	6160	6170	6180	6191	6201	6212	6222	1	2	3	4	5	6	7	8	9
42	6232	6243	6253	6263	6274	6284	6294	6304	6314	6325	1	2	3	4	5	6	7	8	9
43	6335	6345	6355	6365	6375	6385	6395	6405	6415	6425	1	2	3	4	5	6	7	8	9
44	6435	6444	6454	6464	6474	6484	6493	6503	6513	6522	1	2	3	4	5	6	7	8	9
45	6532	6542	6551	6561	6571	6580	6590	6599	6609	6618	1	2	3	4	5	6	7	8	9
46	6628	6637	6646	6656	6665	6675	6684	6693	6702	6712	1	2	3	4	5	6	7	7	8
47	6721	6730	6739	6749	6758	6767	6776	6785	6794	6803	1	2	3	4	5	5	6	7	8
48	6812	6821	6830	6839	6848	6857	6866	6875	6884	6893	1	2	3	4	4	5	6	7	8
49	6902	6911	6920	6028	6937	6946	6955	6964	6972	6981	1	2	3	4	4	5	6	7	8
50	6990	6998	7007	7016	7024	7033	7042	7050	7059	7067	1	2	3	3	4	5	6	7	8
51	7076	7084	7093	7101	7110	7118	7126	7135	7143	7152	1	2	3	3	4	5	6	7	8
52	7160	7168	7177	7185	7193	7202	7210	7218	7226	7235	1	2	2	3	4	5	6	7	7
53	7243	7251	7259	7267	7275	7284	7292	7300	7308	7316	1	2	2	3	4	5	6	6	7
54	7324	7332	7340	7348	7356	7364	7372	7380	7388	7396	1	2	2	3	4	5	6	6	7
N	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9

The proportional parts are stated in full for every tenth at the right-hand side. The logarithm of any number of four significant figures can be read directly by adding the proportional part corresponding to the fourth figure to the tabular number corresponding to the first three figures. There may be an error of 1 in the last place.

LOGARITHMS TO BASE 10

(continued)

N	0	1	2	3	4	5	6	7	8	9	Proportional Parts								
											1	2	3	4	5	6	7	8	9
55	7404	7412	7419	7427	7435	7443	7451	7459	7466	7474	1	2	2	3	4	5	5	6	7
56	7482	7490	7497	7505	7513	7520	7528	7536	7543	7551	1	2	2	3	4	5	5	6	7
57	7559	7566	7574	7582	7589	7597	7604	7612	7619	7627	1	2	2	3	4	5	5	6	7
58	7634	7642	7649	7657	7664	7672	7679	7686	7694	7701	1	1	2	3	4	4	5	6	7
59	7709	7716	7723	7731	7738	7745	7752	7760	7767	7774	1	1	2	3	4	4	5	6	7
60	7782	7789	7796	7803	7810	7818	7825	7832	7839	7846	1	1	2	3	4	4	5	6	6
61	7853	7860	7868	7875	7882	7889	7896	7903	7910	7917	1	1	2	3	4	4	5	6	6
62	7924	7931	7938	7945	7952	7959	7966	7973	7980	7987	1	1	2	3	3	4	5	6	6
63	7993	8000	8007	8014	8021	8028	8035	8041	8048	8055	1	1	2	3	3	4	5	5	6
64	8062	8069	8075	8082	8089	8096	8102	8109	8116	8122	1	1	2	3	3	4	5	5	6
65	8129	8136	8142	8149	8156	8162	8169	8176	8182	8189	1	1	2	3	3	4	5	5	6
66	8195	8202	8209	8215	8222	8228	8235	8241	8248	8254	1	1	2	3	3	4	5	5	6
67	8261	8267	8274	8280	8287	8293	8299	8306	8312	8319	1	1	2	3	3	4	5	5	6
68	8325	8331	8338	8344	8351	8357	8363	8370	8376	8382	1	1	2	3	3	4	4	5	6
69	8388	8395	8401	8407	8414	8420	8426	8432	8439	8445	1	1	2	2	3	4	4	5	6
70	8451	8457	8463	8470	8476	8482	8488	8494	8500	8506	1	1	2	2	3	4	4	5	6
71	8513	8519	8525	8531	8537	8543	8549	8555	8561	8567	1	1	2	2	3	4	4	5	5
72	8573	8579	8585	8591	8597	8603	8609	8615	8621	8627	1	1	2	2	3	4	4	5	5
73	8633	8639	8645	8651	8657	8663	8669	8675	8681	8686	1	1	2	2	3	4	4	5	5
74	8692	8698	8704	8710	8716	8722	8727	8733	8739	8745	1	1	2	2	3	4	4	5	5
75	8751	8756	8762	8768	8774	8779	8785	8791	8797	8802	1	1	2	2	3	3	4	5	5
76	8808	8814	8820	8825	8831	8837	8842	8848	8854	8859	1	1	2	2	3	3	4	5	5
77	8865	8871	8876	8882	8887	8893	8899	8904	8910	8915	1	1	2	2	3	3	4	4	5
78	8921	8927	8932	8938	8943	8949	8954	8960	8965	8971	1	1	2	2	3	3	4	4	5
79	8976	8982	8987	8993	8998	9004	9009	9015	9020	9025	1	1	2	2	3	3	4	4	5
80	9031	9036	9042	9047	9053	9058	9063	9069	9074	9079	1	1	2	2	3	3	4	4	5
81	9085	9090	9096	9101	9106	9112	9117	9122	9128	9133	1	1	2	2	3	3	4	4	5
82	9138	9143	9149	9154	9159	9165	9170	9175	9180	9186	1	1	2	2	3	3	4	4	5
83	9191	9196	9201	9206	9212	9217	9222	9227	9232	9238	1	1	2	2	3	3	4	4	5
84	9243	9248	9253	9258	9263	9269	9274	9279	9284	9289	1	1	2	2	3	3	4	4	5
85	9294	9299	9304	9309	9315	9320	9325	9330	9335	9340	1	1	2	2	3	3	4	4	5
86	9345	9350	9355	9360	9365	9370	9375	9380	9385	9390	1	1	2	2	3	3	4	4	5
87	9395	9400	9405	9410	9415	9420	9425	9430	9435	9440	0	1	1	2	2	3	3	4	4
88	9445	9450	9455	9460	9465	9469	9474	9479	9484	9489	0	1	1	2	2	3	3	4	4
89	9494	9499	9504	9509	9513	9518	9523	9528	9533	9538	0	1	1	2	2	3	3	4	4
90	9542	9547	9552	9557	9562	9566	9571	9576	9581	9586	0	1	1	2	2	3	3	4	4
91	9590	9595	9600	9605	9609	9614	9619	9624	9628	9633	0	1	1	2	2	3	3	4	4
92	9638	9643	9647	9652	9657	9661	9666	9671	9675	9680	0	1	1	2	2	3	3	4	4
93	9685	9689	9694	9699	9703	9708	9713	9717	9722	9727	0	1	1	2	2	3	3	4	4
94	9731	9736	9741	9745	9750	9754	9759	9763	9768	9773	0	1	1	2	2	3	3	4	4
95	9777	9782	9786	9791	9795	9800	9805	9809	9814	9818	0	1	1	2	2	3	3	4	4
96	9823	9827	9832	9836	9841	9845	9850	9854	9859	9863	0	1	1	2	2	3	3	4	4
97	9868	9872	9877	9881	9886	9890	9894	9899	9903	9908	0	1	1	2	2	3	3	4	4
98	9912	9917	9921	9926	9930	9934	9939	9943	9948	9952	0	1	1	2	2	3	3	4	4
99	9956	9961	9965	9969	9974	9978	9983	9987	9991	9996	0	1	1	2	2	3	3	3	4
N	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9

The proportional parts are stated in full for every tenth at the right-hand side. The logarithm of any number of four significant figures can be read directly by adding the proportional part corresponding to the fourth figure to the tabular number corresponding to the first three figures. There may be an error of 1 in the last place.

NATURAL (NAPIERIAN) LOGARITHMS

The natural logarithm of a number is the index of the power to which the base e (2.7182818) must be raised in order to equal the number.

Example: $\log_e 4.12 = \ln 4.12 = 1.4159$.

The table gives the natural logarithms of numbers from 1.00 to 9.99 directly, and permits finding logarithms of numbers outside that range by the addition or subtraction of the natural logarithms of powers of 10.

Example: $\ln 679. = \ln 6.79 + \ln 10^2 = 1.9155 + 4.6052 = 6.5207$
$\ln 0.0679 = \ln 6.79 - \ln 10^2 = 1.9155 - 4.6052 = -2.6897$

Natural Logarithms of 10^n

$\ln 10 = 2.302585$	$\ln 10^4 = 9.210340$	$\ln 10^7 = 16.118096$
$\ln 10^2 = 4.605170$	$\ln 10^5 = 11.512925$	$\ln 10^8 = 18.420681$
$\ln 10^3 = 6.907755$	$\ln 10^6 = 13.815511$	$\ln 10^9 = 20.723266$

To obtain the common logarithm, the natural logarithm is multiplied by $\log_{10} e$, which is 0.434294, or $\log_{10} N = 0.434294 \ln N$.

N	0	1	2	3	4	5	6	7	8	9
1.0	0.00000	.00995	.01980	.02956	.03922	.04879	.05827	.06766	.07696	.08618
.1	.09531	.10436	.11333	.12222	.13103	.13976	.14842	.15700	.16551	.17395
.2	.18232	.19062	.19885	.20701	.21511	.22314	.23111	.23902	.24686	.25464
.3	.26236	.27003	.27763	.28518	.29267	.30010	.30748	.31481	.32208	.32930
.4	.33647	.34359	.35066	.35767	.36464	.37156	.37844	.38526	.39204	.39878
.5	.40547	.41211	.41871	.42527	.43178	.43825	.44469	.45108	.45742	.46373
.6	.47000	.47623	.48243	.48858	.49470	.50078	.50682	.51282	.51879	.52473
.7	.53063	.53649	.54232	.54812	.55389	.55962	.56531	.57098	.57661	.58222
.8	.58779	.59333	.59884	.60432	.60977	.61519	.62058	.62594	.63127	.63658
.9	.64185	.64710	.65233	.65752	.66269	.66783	.672[illegible]	.67803	.68310	.68813
2.0	0.69315	.69813	.70310	.70804	.71295	.71784	.72271	.72755	.73237	.73716
1	.74194	.74669	.75142	.75612	.76081	.76547	.77011	.77473	.77932	.78390
.2	.78846	.79299	.79751	.80200	.80648	.81093	.81536	.81978	.82418	.82855
.3	.83291	.83725	.84157	.84587	.85015	.85442	.85866	.86289	.86710	.87129
4	.87547	.87963	.88377	.88789	.89200	.89609	.90016	.90422	.90826	.91228
.5	.91629	.92028	.92426	.92822	.93216	.93609	.94001	.94391	.94779	.95166
.6	.95551	.95935	.96317	.96698	.97078	.97456	.97833	.98208	.98582	.98954
.7	.99325	.99695	*.00063	*.00430	*.00796	*.01160	*.01523	*.01885	*.02245	*.02604
.8	1.02962	.03318	.03674	.04028	.04380	.04732	.05082	.05431	.05779	.06126
9	.06471	.06815	.07158	.07500	.07841	.08181	.08519	.08853	.09192	.09527
3.0	1.09861	.10194	.10526	.10856	.11186	.11514	.11841	.12168	.12493	.12817
.1	.13140	.13462	.13783	.14103	.14422	.14740	.15057	.15373	.15688	.16002
2	.16315	.16627	.16938	.17248	.17557	.17865	.18173	.18479	.18784	.19089
.3	.19392	.19695	.19996	.20297	.20597	.20896	.21194	.21491	.21788	.22083
.4	.22378	.22671	.22964	.23256	.23547	.23837	.24127	.24415	.24703	.24990
.5	.25276	.25562	.25846	.26130	.26413	.26695	.26976	.27257	.27536	.27815
.6	.28093	.28371	.28647	.28923	.29198	.29473	.29746	.30019	.30291	.30563
.7	.30833	.31103	.31372	.31641	.31909	.32176	.32442	.32708	.32972	.33237
.8	.33500	.33763	.34025	.34286	.34547	.34807	.35067	.35325	.35584	.35841
.9	.36098	.36354	.36609	.36864	.37118	.37372	.37624	.37877	.38128	.38379
4.0	1.38629	.38879	.39128	.39377	.39624	.39872	.40118	.40364	.40610	.40854
.1	.41099	.41342	.41585	.41828	.42070	.42311	.42552	.42792	.43031	.43270
.2	.43508	.43746	.43984	.44220	.44456	.44692	.44927	.45161	.45395	.45629
.3	.45862	.46094	.46326	.46557	.46787	.47018	.47247	.47476	.47705	.47933
.4	.48160	.48387	.48614	.48840	.49065	.49290	.49515	.49739	.49962	.50185
.5	.50408	.50630	.50851	.51072	.51293	.51513	.51732	.51951	.52170	.52388
.6	.52606	.52823	.53039	.53256	.53471	.53687	.53902	.54116	.54330	.54543
.7	.54756	.54969	.55181	.55393	.55604	.55814	.56025	.56235	.56444	.56653
.8	.56862	.57070	.57277	.57485	.57691	.57898	.58104	.58309	.58515	.58719
.9	.58924	.59127	.59331	.59534	.59737	.59939	.60141	.60342	.60543	.60744

NATURAL (NAPIERIAN) LOGARITHMS

(continued)

N	0	1	2	3	4	5	6	7	8	9
5.0	1.60944	.61144	.61343	.61542	.61741	.61939	.62137	.62334	.62531	.62728
.1	.62924	.63120	.63315	.63511	.63705	.63900	.64094	.64287	.64481	.64673
.2	.64866	.65058	.65250	.65441	.65632	.65823	.66013	.66203	.66393	.66582
.3	.66771	.66950	.67147	.67335	.67523	.67710	.67896	.68083	.68269	.68455
.4	.68640	.68825	.69010	.69194	.69378	.69562	.69745	.69928	.70111	.70293
.5	.70475	.70656	.70838	.71019	.71199	.71380	.71560	.71740	.71919	.72098
.6	.72277	.72455	.72633	.72811	.72988	.73166	.73342	.73519	.73695	.73871
.7	.74047	.74222	.74397	.74572	.74746	.74920	.75094	.75267	.75440	.75613
.8	.75786	.75958	.76130	.76302	.76473	.76644	.76815	.76985	.77156	.77326
.9	.77495	.77665	.77834	.78002	.78171	.78339	.78507	.78675	.78842	.79009
6.0	1.79176	.79342	.79509	.79675	.79840	.80006	.80171	.80336	.80500	.80665
.1	.80829	.80993	.81156	.81319	.81482	.81645	.81808	.81970	.82132	.82294
.2	.82455	.82616	.82777	.82938	.83098	.83258	.83418	.83578	.83737	.83896
.3	.84055	.84214	.84372	.84530	.84688	.84845	.85003	.85160	.85317	.85473
.4	.85630	.85786	.85942	.86097	.86253	.86408	.86563	.86718	.86872	.87026
.5	.87180	.87334	.87487	.87641	.87794	.87947	.88099	.88251	.88403	.88555
.6	.88707	.88858	.89010	.89160	.89311	.89462	.89612	.89762	.89912	.90061
.7	.90211	.90360	.90509	.90658	.90806	.90954	.91102	.91250	.91398	.91545
.8	.91692	.91839	.91986	.92132	.92279	.92425	.92571	.92716	.92862	.93007
.9	.93152	.93297	.93442	.93586	.93730	.93874	.94018	.94162	.94305	.94448
7.0	1.94591	.94734	.94876	.95019	.95161	.95303	.95445	.95586	.95727	.95869
.1	.96009	.96150	.96291	.96431	.96571	.96711	.96851	.96991	.97130	.97269
.2	.97408	.97547	.97685	.97824	.97962	.98100	.98238	.98376	.98513	.98650
.3	.98787	.98924	.99061	.99198	.99334	.99470	.99606	.99742	.99877	*.00013
.4	2.00148	.00283	.00418	.00553	.00687	.00821	.00956	.01089	.01223	.01357
.5	.01490	.01624	.01757	.01890	.02022	.02155	.02287	.02419	.02551	.02683
.6	.02815	.02946	.03078	.03209	.03340	.03471	.03601	.03732	.03862	.03992
.7	.04122	.04252	.04381	.04511	.04640	.04769	.04898	.05027	.05156	.05284
.8	.05412	.05540	.05668	.05796	.05924	.06051	.06179	.06306	.06433	.06560
.9	.06686	.06813	.06939	.07065	.07191	.07317	.07443	.07568	.07694	.07819
8.0	2.07944	.08069	.08194	.08318	.08443	.08567	.08691	.08815	.08939	.09063
.1	.09186	.09310	.09433	.09556	.09679	.09802	.09924	.10047	.10169	.10291
.2	.10413	.10535	.10657	.10779	.10900	.11021	.11142	.11263	.11384	.11505
.3	.11626	.11746	.11866	.11986	.12106	.12226	.12346	.12465	.12585	.12704
.4	.12823	.12942	.13061	.13180	.13298	.13417	.13535	.13653	.13771	.13889
.5	.14007	.14124	.14242	.14359	.14476	.14593	.14710	.14827	.14943	.15060
.6	.15176	.15292	.15409	.15524	.15640	.15756	.15871	.15987	.16102	.16217
.7	.16332	.16447	.16562	.16677	.16791	.16905	.17020	.17134	.17248	.17361
.8	.17475	.17589	.17702	.17816	.17929	.18042	.18155	.18267	.18380	.18493
.9	.18605	.18717	.18830	.18942	.19054	.19165	.19277	.19389	.19500	.19611
9.0	2.19722	.19834	.19944	.20055	.20166	.20276	.20387	.20497	.20607	.20717
.1	.20827	.20937	.21047	.21157	.21266	.21375	.21485	.21594	.21703	.21812
.2	.21920	.22029	.22138	.22246	.22354	.22462	.22570	.22678	.22786	.22894
.3	.23001	.23109	.23216	.23324	.23431	.23538	.23645	.23751	.23858	.23965
.4	.24071	.24177	.24284	.24390	.24496	.24601	.24707	.24813	.24918	.25024
.5	.25129	.25234	.25339	.25444	.25549	.25654	.25759	.25863	.25968	.26072
.6	.26176	.26280	.26384	.26488	.26592	.26696	.26799	.26903	.27006	.27109
.7	.27213	.27316	.27419	.27521	.27624	.27727	.27829	.27932	.28034	.28136
.8	.28238	.28340	.28442	.28544	.28646	.28747	.28849	.28950	.29051	.29152
.9	.29253	.29354	.29455	.29556	.29657	.29757	.29858	.29958	.30058	.30158

VALUES AND LOGARITHMS OF EXPONENTIAL FUNCTIONS

Note: If $0 < x < .01$ the value for e^{-x} can be found by the use of $(1-x)$ or the value for e^x can be found by the use of $(1+x)$.

x	e^x		e^{-x}	x	e^x		e^{-x}
	Value	$\log_{10}$	Value		Value	$\log_{10}$	Value
0.00	1.0000	.00000	1.00000	0.50	1.6487	.21715	.60653
0.01	1.0101	.00434	.99005	0.51	1.6653	.22149	.60050
0.02	1.0202	.00869	.98020	0.52	1.6820	.22583	.59452
0.03	1.0305	.01303	.97045	0.53	1.6989	.23018	.58860
0.04	1.0408	.01737	.96079	0.54	1.7160	.23452	.58275
0.05	1.0513	.02171	.95123	0.55	1.7333	.23886	.57695
0.06	1.0618	.02606	.94176	0.56	1.7507	.24320	.57121
0.07	1.0725	.03040	.93239	0.57	1.7683	.24755	.56553
0.08	1.0833	03474	.92312	0.58	1.7860	.25189	.55990
0.09	1.0942	.03909	.91393	0.59	1.8040	.25623	.55433
0.10	1.1052	.04343	.90484	0.60	1.8221	.26058	.54881
0.11	1.1163	.04777	.89583	0.61	1.8404	.26492	.54335
0.12	1.1275	.05212	.88692	0.62	1.8589	.26926	.53794
0.13	1.1388	.05646	.87809	0.63	1.8776	.27361	.53259
0.14	1.1503	.06080	.86936	0.64	1.8965	.27795	.52729
0.15	1.1618	.06514	.86071	0.65	1.9155	.28229	.52205
0.16	1.1735	.06949	.85214	0.66	1.9348	.28664	.51685
0.17	1.1853	.07383	.84366	0.67	1.9542	.29098	.51171
0.18	1.1972	.07817	.83527	0.68	1.9739	.29532	.50662
0.19	1.2092	.08252	.82696	0.69	1.9937	.29966	.50158
0.20	1.2214	.08686	.81873	0.70	2.0138	.30401	.49659
0.21	1.2337	.09120	.81058	0.71	2.0340	.30835	.49164
0.22	1.2461	.09554	.80252	0.72	2.0544	.31269	.48675
0.23	1.2586	.09989	.79453	0.73	2.0751	.31703	.48191
0.24	1.2712	.10423	.78663	0.74	2.0959	.32138	.47711
0.25	1.2840	.10857	.77880	0.75	2.1170	.32572	.47237
0.26	1.2969	.11292	.77105	0.76	2.1383	.33006	.46767
0.27	1.3100	.11726	.76338	0.77	2.1598	.33441	.46301
0.28	1.3231	.12160	.75578	0.78	2.1815	.33875	.45841
0.29	1.3364	.12595	.74826	0.79	2.2034	.34309	.45384
0.30	1.3499	.13029	.74082	0.80	2.2255	.34744	.44933
0.31	1.3634	.13463	.73345	0.81	2.2479	.35178	.44486
0.32	1.3771	.13897	.72615	0.82	2.2705	.35612	.44043
0.33	1.3910	.14332	.71892	0.83	2.2933	.36046	.43605
0.34	1.4049	.14766	.71177	0.84	2.3164	.36481	.43171
0.35	1.4191	.15200	.70469	0.85	2.3396	.36915	.42741
0.36	1.4333	.15635	.69768	0.86	2.3632	.37349	.42316
0.37	1.4477	.16069	.69073	0.87	2.3869	.37784	.41895
0.38	1.4623	.16503	.68386	0.88	2.4109	.38218	.41478
0.39	1.4770	.16937	.67706	0.89	2.4351	.38652	.41066
0.40	1.4918	.17372	.67032	0.90	2.4596	.39087	.40657
0.41	1.5068	.17806	.66365	0.91	2.4843	.39521	.40252
0.42	1.5220	.18240	.65705	0.92	2.5093	.39955	.39852
0.43	1.5373	.18675	.65051	0.93	2.5345	.40389	.39455
0.44	1.5527	.19109	.64404	0.94	2.5600	.40824	.39063
0.45	1.5683	.19543	.63763	0.95	2.5857	.41258	.38674
0.46	1.5841	.19978	.63128	0.96	2.6117	.41692	.38289
0.47	1.6000	.20412	.62500	0.97	2.6379	.42127	.37908
0.48	1.6161	.20846	.61878	0.98	2.6645	.42561	.37531
0.49	1.6323	.21280	.61263	0.99	2.6912	.42995	.37158
0.50	1.6487	.21715	.60653	1.00	2.7183	.43429	.36788

VALUES AND LOGARITHMS OF EXPONENTIAL FUNCTIONS

(continued)

x	e^x		e^{-x}	x	e^x		e^{-x}
	Value	Log_{10}	Value		Value	Log_{10}	Value
1.00	2.7183	.43429	.36788	1.50	4.4817	.65144	.22313
1.01	2.7456	.43864	.36422	1.51	4.5267	.65578	.22091
1.02	2.7732	.44298	.36060	1.52	4.5722	.66013	.21871
1.03	2.8011	.44732	.35701	1.53	4.6182	.66447	.21654
1.04	2.8292	.45167	.35345	1.54	4.6646	.66881	.21438
1.05	2.8577	.45601	.34994	1.55	4.7115	.67316	.21225
1.06	2.8864	.46035	.34646	1.56	4.7588	.67750	.21014
1.07	2.9154	.46470	.34301	1.57	4.8066	.68184	.20805
1.08	2.9447	.46904	.33960	1.58	4.8550	.68619	.20598
1.09	2.9743	.47338	.33622	1.59	4.9037	.69053	.20393
1.10	3.0042	.47772	.33287	1.60	4.9530	.69487	.20190
1.11	3.0344	.48207	.32956	1.61	5.0028	.69921	.19989
1.12	3.0649	.48641	.32628	1.62	5.0531	.70356	.19790
1.13	3.0957	.49075	.32303	1.63	5.1039	.70790	.19593
1.14	3.1268	.49510	.31982	1.64	5.1552	.71224	.19398
1.15	3.1582	.49944	.31664	1.65	5.2070	.71659	.19205
1.16	3.1899	.50378	.31349	1.66	5.2593	.72093	.19014
1.17	3.2220	.50812	.31037	1.67	5.3122	.72527	.18825
1.18	3.2544	.51247	.30728	1.68	5.3656	.72961	.18637
1.19	3.2871	.51681	.30422	1.69	5.4195	.73396	.18452
1.20	3.3201	.52115	.30119	1.70	5.4739	.73830	.18268
1.21	3.3535	.52550	.29820	1.71	5.5290	.74264	.18087
1.22	3.3872	.52984	.29523	1.72	5.5845	.74699	.17907
1.23	3.4212	.53418	.29229	1.73	5.6407	.75133	.17728
1.24	3.4556	.53853	.28938	1.74	5.6973	.75567	.17552
1.25	3.4903	.54287	.28650	1.75	5.7546	.76002	.17377
1.26	3.5254	.54721	.28365	1.76	5.8124	.76436	.17204
1.27	3.5609	.55155	.28083	1.77	5.8709	.76870	.17033
1.28	3.5966	.55590	.27804	1.78	5.9299	.77304	.16864
1.29	3.6328	.56024	.27527	1.79	5.9895	.77739	.16696
1.30	3.6693	.56458	.27253	1.80	6.0496	.78173	.16530
1.31	3.7062	.56893	.26982	1.81	6.1104	.78607	.16365
1.32	3.7434	.57327	.26714	1.82	6.1719	.79042	.16203
1.33	3.7810	.57761	.26448	1.83	6.2339	.79476	.16041
1.34	3.8190	.58195	.26185	1.84	6.2965	.79910	.15882
1.35	3.8574	.58630	.25924	1.85	6.3598	.80344	15724
1.36	3.8962	.59064	.25666	1.86	6.4237	.80779	.15567
1.37	3.9354	.69498	.25411	1.87	6.4883	.81213	.15412
1.38	3.9749	.59933	.25158	1.88	6.5535	.81647	.15259
1.39	4.0149	.60367	.24908	1.89	6.6194	.82082	.15107
1.40	4.0552	.60801	.24660	1.90	6.6859	.82516	.14957
1.41	4.0960	.61236	.24414	1.91	6.7531	.82950	.14808
1.42	4.1371	.61670	.24171	1.92	6.8210	.83385	14661
1.43	4.1787	.62104	.23931	1.93	6.8895	.83819	.14515
1.44	4.2207	.62538	.23693	1.94	6.9588	.84253	.14370
1.45	4.2631	.62973	.23457	1.95	7.0287	.84687	.14227
1.46	4.3060	.63407	.23224	1.96	7.0993	.85122	.14086
1.47	4.3492	.63841	.22993	1.97	7.1707	.85556	.13946
1.48	4.3929	.64276	.22764	1.98	7.2427	.85990	.13807
1.49	4.4371	.64710	.22537	1.99	7.3155	.86425	.13670
1.50	4.4817	.65144	.22313	2.00	7.3891	.86859	.13534

VALUES AND LOGARITHMS OF EXPONENTIAL FUNCTIONS

(continued)

x	e^x		e^{-x}	x	e^x		e^{-x}
	Value	Log_{10}	Value		Value	Log_{10}	Value
2.00	7.3891	.86859	.13534	2.50	12.182	1.08574	.08208
2.01	7.4633	.87293	.13399	2.51	12.305	1.09008	.08127
2.02	7.5383	.87727	.13266	2.52	12.429	1.09442	.08046
2.03	7.6141	.88162	.13134	2.53	12.554	1.09877	.07966
2.04	7.6906	.88596	.13003	2.54	12.680	1.10311	.07887
2.05	7.7679	.89030	.12873	2.55	12.807	1.10745	.07808
2.06	7.8460	.89465	.12745	2.56	12.936	1.11179	.07730
2.07	7.9248	.89899	.12619	2.57	13.066	1.11614	.07654
2.08	8.0045	.90333	.12493	2.58	13.197	1.12048	.07577
2.09	8.0849	.90768	.12369	2.59	13.330	1.12482	.07502
2.10	8.1662	.91202	.12246	2.60	13.464	1.12917	.07427
2.11	8.2482	.91636	.12124	2.61	13.599	1.13351	.07353
2.12	8.3311	.92070	.12003	2.62	13.736	1.13785	.07280
2.13	8.4149	.92505	.11884	2.63	13.874	1.14219	.07208
2.14	8.4994	.92939	.11765	2.64	14.013	1.14654	.07136
2.15	8.5849	.93373	.11648	2.65	14.154	1.15088	.07065
2.16	8.6711	.93808	.11533	2.66	14.296	1.15522	.06995
2.17	8.7583	.94242	.11418	2.67	14.440	1.15957	.06925
2.18	8.8463	.94676	.11304	2.68	14.585	1.16391	.06856
2.19	8.9352	.95110	.11192	2.69	14.732	1.16825	.06788
2.20	9.0250	.95545	.11080	2.70	14.880	1.17260	.06721
2.21	9.1157	.95979	.10970	2.71	15.029	1.17694	.06654
2.22	9.2073	.96413	.10861	2.72	15.180	1.18128	.06587
2.23	9.2999	.96848	.10753	2.73	15.333	1.18562	.06522
2.24	9.3933	.97282	.10646	2.74	15.487	1.18997	.06457
2.25	9.4877	.97716	.10540	2.75	15.643	1.19431	.06393
2.26	9.5831	.98151	.10435	2.76	15.800	1.19865	.06329
2.27	9.6794	.98585	.10331	2.77	15.959	1.20300	.06266
2.28	9.7767	.99019	.10228	2.78	16.119	1.20734	.06204
2.29	9.8749	.99453	.10127	2.79	16.281	1.21168	.06142
2.30	9.9742	.99888	.10026	2.80	16.445	1.21602	.06081
2.31	10.074	1.00322	.09926	2.81	16.610	1.22037	.06020
2.32	10.176	1.00756	.09827	2.82	16.777	1.22471	.05961
2.33	10.278	1.01191	.09730	2.83	16.945	1.22905	.05901
2.34	10.381	1.01625	.09633	2.84	17.116	1.23340	.05843
2.35	10.486	1.02059	.09537	2.85	17.288	1.23774	.05784
2.36	10.591	1.02493	.09442	2.86	17.462	1.24208	.05727
2.37	10.697	1.02928	.09348	2.87	17.637	1.24643	.05670
2.38	10.805	1.03362	.09255	2.88	17.814	1.25077	.05613
2.39	10.913	1.03796	.09163	2.89	17.993	1.25511	.05558
2.40	11.023	1.04231	.09072	2.90	18.174	1.25945	.05502
2.41	11.134	1.04665	.08982	2.91	18.357	1.26380	.05448
2.42	11.246	1.05099	.08892	2.92	18.541	1.26814	.05393
2.43	11.359	1.05534	.08804	2.93	18.728	1.27248	.05340
2.44	11.473	1.05968	.08716	2.94	18.916	1.27683	.05287
2.45	11.588	1.06402	.08629	2.95	19.106	1.28117	.05234
2.46	11.705	1.06836	.08543	2.96	19.298	1.28551	.05182
2.47	11.822	1.07271	.08458	2.97	19.492	1.28985	.05130
2.48	11.941	1.07705	.08374	2.98	19.688	1.29420	.05079
2.49	12.061	1.08139	.08291	2.99	19.886	1.29854	.05029
2.50	12.182	1.08574	.08208	3.00	20.086	1.30288	.04979

VALUES AND LOGARITHMS OF EXPONENTIAL FUNCTIONS

(continued)

x	e^x		e^{-x}
	Value	Log$_{10}$	Value
3.00	20.086	1.30288	.04979
3.05	21.115	1.32460	.04736
3.10	22.198	1.34631	.04505
3.15	23.336	1.36803	.04285
3.20	24.533	1.38974	.04076
3.25	25.790	1.41146	.03877
3.30	27.113	1.43317	.03688
3.35	28.503	1.45489	.03508
3.40	29.964	1.47660	.03337
3.45	31.500	1.49832	.03175
3.50	33.115	1.52003	.03020
3.55	34.813	1.54175	.02872
3.60	36.598	1.56346	.02732
3.65	38.475	1.58517	.02599
3.70	40.447	1.60689	.02472
3.75	42.521	1.62860	.02352
3.80	44.701	1.65032	.02237
3.85	46.993	1.67203	.02128
3.90	49.402	1.69375	.02024
3.95	51.935	1.71546	.01925
4.00	54.598	1.73718	.01832
4.10	60.340	1.78061	.01657
4.20	66.686	1.82404	.01500
4.30	73.700	1.86747	.01357
4.40	81.451	1.91090	.01227
4.50	90.017	1.95433	.01111
4.60	99.484	1.99775	.01005
4.70	109.95	2.04118	.00910
4.80	121.51	2.08461	.00823
4.90	134.29	2.12804	.00745
5.00	148.41	2.17147	.00674
5.10	164.02	2.21490	.00610
5.20	181.27	2.25833	.00552
5.30	200.34	2.30176	.00499
5.40	221.41	2.34519	.00452
5.50	244.69	2.38862	.00409
5.60	270.43	2.43205	.00370
5.70	298.87	2.47548	.00335
5.80	330.30	2.51891	.00303
5.90	365.04	2.56234	.00274
6.00	403.43	2.60577	.00248
6.25	518.01	2.71434	.00193
6.50	665.14	2.82291	.00150
6.75	854.06	2.93149	.00117
7.00	1096.6	3.04006	.00091
7.50	1808.0	3.25721	.00055
8.00	2981.0	3.47436	.00034
8.50	4914.8	3.69150	.00020
9.00	8103.1	3.90865	.00012
9.50	13360.	4.12580	.00007
10.00	22026.	4.34294	.00005

SELECTED PRINCIPLES OF ALGEBRA

I OPERATIONS WITH EXPONENTS

$$(a^m) \times (a^n) = a^{m+n}$$

$$(a^m)^n = a^{mn}$$

$$(a^m) \times (b^m) = (ab)^m$$

$$(a^m) \div (a^n) = a^{m-n}$$

$$\frac{a^n}{b^n} = \left(\frac{a}{b}\right)^n$$

II FACTORING

Common factor

$$ax + ay = a(x+y)$$

Difference of two squares

$$a^2 - b^2 = (a+b)\ (a-b)$$

Trinomial perfect square

$$a^2 + 2ab + b^2 = (a+b)^2$$

$$a^2 - 2ab + b^2 = (a-b)^2$$

Other trinomials

$$x^2 + (a+b)x + ab = (x+a)\ (x+b)$$

$$acx^2 + (ad+bc)x + bd = (ax+b)\ (cx+d)$$

Other types

$$a^3 + b^3 = (a+b)\ (a^2 - ab + b^2)$$

$$a^3 - b^3 = (a-b)\ (a^2 + ab + b^2)$$

$$a^2 + b^2 + c^2 + 2ab + 2ac + 2bc = (a+b+c)^2$$

III OPERATIONS INVOLVING FRACTIONS

$$\frac{a}{b} + \frac{c}{b} = \frac{a+c}{b}$$

$$\frac{a}{b} - \frac{c}{b} = \frac{a-c}{b}$$

$$\left(\frac{a}{b}\right) \times \left(\frac{c}{d}\right) = \frac{ac}{bd}$$

$$\left(\frac{a}{b}\right) \div \left(\frac{c}{d}\right) = \left(\frac{a}{b}\right) \times \left(\frac{d}{c}\right) = \frac{ad}{bc}$$

IV OPERATIONS INVOLVING RADICALS

$$\left(\sqrt[n]{a}\right)^n = a$$

$$\sqrt[n]{a^n} = a$$

$$\sqrt[m]{\sqrt[n]{a}} = \sqrt[mn]{a}$$

$$\sqrt[n]{a}\,\sqrt[n]{b} = \sqrt[n]{ab}$$

$$\frac{\sqrt[n]{a}}{\sqrt[n]{b}} = \sqrt[n]{\frac{a}{b}}$$

$$a\sqrt[n]{b} + c\sqrt[n]{b} = (a+c)\sqrt[n]{b}$$

$$a\sqrt[n]{b} - c\sqrt[n]{b} = (a-c)\sqrt[n]{b}$$

$$\left(a\sqrt[n]{b}\right) \times \left(c\sqrt[n]{d}\right) = ac\sqrt[n]{bd}$$

SELECTED PRINCIPLES OF ALGEBRA

(continued)

V QUADRATIC EQUATION

$$ax^2 + bx + c = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2}$$

If $b^2 - 4ac$ is > 0 the roots are real and unequal.

If $b^2 - 4ac = 0$ the roots are real and equal.

If $b^2 - 4ac$ is < 0 the roots are imaginary.

VI BINOMIAL THEOREM

Where n is a positive integer

$$(a+b)^n = a^n + \frac{n}{1} a^{n-1} b + \frac{n(n-1)}{1 \cdot 2} a^{n-2} b^2 + \frac{n(n-1)(n-2)}{1 \cdot 2 \cdot 3} a^{n-3} b^3 + \ldots\ldots\ldots + b^n$$

VII PROGRESSIONS

The $n^{\underline{th}}$ term of an arithmetic progression

$$a_n = a_1 + (n-1)d$$

The sum of an arithmetic progression

$$S_n = \frac{n}{2}(a_1 + a_n)$$

$$S_n = \frac{n}{2}\left[2a_1 + (n-1)d\right]$$

The $n^{\underline{th}}$ term of a geometric progression

$$a_n = a_1 r^{n-1}$$

The sum of a geometric progression is

$$S_n = a_1\left(\frac{r^n - 1}{r - 1}\right) \quad \text{where } r \neq 1$$

$$S_n = a_1\left(\frac{1 - r^n}{1 - r}\right) \quad \text{where } r < 1$$

The sum of an infinite geometric progression is

$$S = \frac{a_1}{1 - r} \quad \text{where } r < 1$$

VIII SCIENTIFIC NOTATION AND LOGARITHMS

A Scientific Notation

Any number may be written as the product of a number having a single non-zero digit to the left of the decimal point and a positive or negative power of ten. The power of ten is the number of places which the decimal point is moved from its existing position to get the number in scientific notation form. The sign of the exponent is positive if the decimal point is moved to the left and negative if the decimal point is moved to the right.

$$83,100,000 = 8.31 \times 10^7$$

$$0.00000040 = 4.0 \times 10^{-7}$$

B Logarithms

When $a^b = x$; $\log_a x = b$

$$\log x + \log y = \log(xy)$$

$$x \log y = \log(y^x)$$

$$\log x - \log y = \log\left(\frac{x}{y}\right)$$

$$\log\left(\sqrt[n]{x}\right) = \frac{1}{n}\log x$$

$$\log_a N = (\log_b N)(\log_a b)$$

$$\log_a b = \frac{1}{\log_b a}$$

$$\log_{10} N = 0.4343 \log_e N$$

$$\log_e N = \frac{\log_{10} N}{0.4343} = 2.3026 \log_{10} N$$

SELECTED PRINCIPLES OF ALGEBRA
(continued)

IX DETERMINANTS

Simultaneous equations:

$$ax + by + cx = d$$

$$ex + fy + gz = h$$

$$ix + jy + kz = l$$

Determinant solutions:

$$x = \frac{\begin{vmatrix} d & b & c \\ h & f & g \\ l & j & k \end{vmatrix}}{\begin{vmatrix} a & b & c \\ e & f & g \\ i & j & k \end{vmatrix}}$$

$$x = \frac{dfk + bgl + cjh - cfl - gjd - khb}{afk + bgi + cje - cfi - gja - keb}$$

$$y = \frac{\begin{vmatrix} a & d & c \\ e & h & g \\ i & l & k \end{vmatrix}}{\begin{vmatrix} a & b & c \\ e & f & g \\ i & j & k \end{vmatrix}}$$

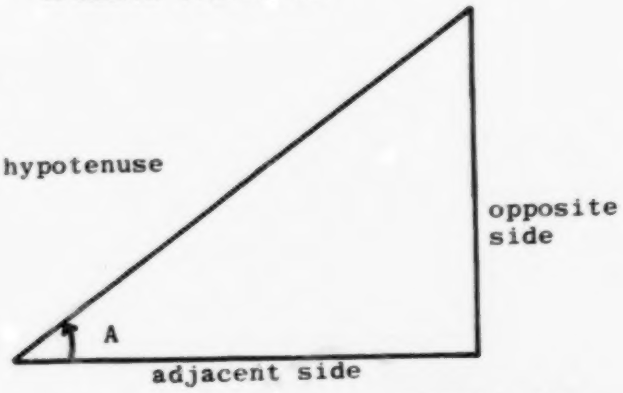
$$y = \frac{ahk + dgi + cle - chi - gla - ked}{afk + bgi + cje - cfi - gja - keb}$$

$$z = \frac{\begin{vmatrix} a & b & d \\ e & f & h \\ i & j & l \end{vmatrix}}{\begin{vmatrix} a & b & c \\ e & f & g \\ i & j & k \end{vmatrix}}$$

$$z = \frac{afl + bhi + dje - dfi - hja - leb}{afk + bgi + cje - cfi - gja - keb}$$

SELECTED TRIGONOMETRIC RELATIONSHIPS

I FUNDAMENTAL RELATIONSHIPS IN A RIGHT TRIANGLE



sine A = sin A = $\frac{\text{opposite side}}{\text{hypotenuse}}$

cosine A = cos A = $\frac{\text{adjacent side}}{\text{hypotenuse}}$

tanget A = tan A = $\frac{\text{opposite side}}{\text{adjacent side}}$

cotangent A = cot A = $\frac{\text{adjacent side}}{\text{opposite side}}$

secant A = sec A = $\frac{\text{hypotenuse}}{\text{adjacent side}}$

cosecant A = csc A = $\frac{\text{hypotenuse}}{\text{opposite side}}$

Pythagorean Theorem

$$(\text{hypotenuse})^2 = (\text{adjacent side})^2 + (\text{opposite side})^2$$

II TRIGONOMETRIC IDENTITIES

1 $\sin A = \frac{1}{\csc A}$

2 $\cos A = \frac{1}{\sec A}$

3 $\tan A = \frac{1}{\cot A}$

4 $\tan A = \frac{\sin A}{\cos A}$

5 $\cot A = \frac{\cos A}{\sin A}$

6 $\sin^2 A + \cos^2 A = 1$

7 $\sec^2 A = 1 + \tan^2 A$

8 $\csc^2 A = 1 + \cot^2 A$

9 $\sin(A+B) = \sin A \cos B + \cos A \sin B$

10 $\cos(A+B) = \cos A \cos B - \sin A \sin B$

11 $\sin(A-B) = \sin A \cos B - \cos A \sin B$

12 $\cos(A-B) = \cos A \cos B + \sin A \sin B$

13 $\tan(A+B) = \frac{\tan A + \tan B}{1 - \tan A \tan B}$

14 $\cot(A+B) = \frac{\cot A \cot B - 1}{\cot A + \cot B}$

15 $\tan(A-B) = \frac{\tan A - \tan B}{1 + \tan A \tan B}$

16 $\cot(A-B) = \frac{\cot A \cot B + 1}{\cot B - \cot A}$

17 $\sin 2A = 2 \sin A \cos A$

18 $\cos 2A = \cos^2 A - \sin^2 A$

19 $\cos 2A = 1 - 2 \sin^2 A$

20 $\cos 2A = 2 \cos^2 A - 1$

21 $\tan 2A = \frac{2 \tan A}{1 - \tan^2 A}$

22 $\sin \frac{A}{2} = \pm \left(\frac{1 - \cos A}{2} \right)^{\frac{1}{2}}$

23 $\cos \frac{A}{2} = \pm \left(\frac{1 + \cos A}{2} \right)^{\frac{1}{2}}$

24 $\tan \frac{A}{2} = \pm \left(\frac{1 - \cos A}{1 + \cos A} \right)^{\frac{1}{2}}$

25 $\tan \frac{A}{2} = \frac{\sin A}{1 + \cos A}$

26 $\tan \frac{A}{2} = \frac{1 - \cos A}{\sin A}$

SELECTED TRIGONOMETRIC RELATIONSHIPS
(continued)

27 $\sin A + \sin B = 2\sin\left(\frac{A+B}{2}\right)\cos\left(\frac{A-B}{2}\right)$

28 $\sin A - \sin B = 2\cos\left(\frac{A+B}{2}\right)\sin\left(\frac{A-B}{2}\right)$

29 $\cos A + \cos B = 2\cos\left(\frac{A+B}{2}\right)\cos\left(\frac{A-B}{2}\right)$

30 $\cos A - \cos B = -2\sin\left(\frac{A+B}{2}\right)\sin\left(\frac{A-B}{2}\right)$

III SIGNS OF TRIGONOMETRIC FUNCTIONS

2nd quadrant (90° to 180°): positive functions: sin and csc negative functions: cos, tan, cot and sec	1st quadrant (0° to 90°): positive functions sin, cos, tan, cot, sec and csc
3rd quadrant (180° to 270°): positive functions: tan and cot negative functions: sin, cos, sec and csc	4th quadrant (270° to 360°): positive functions: cos and sec negative functions: sin, tan, cot and csc

SELECTED TRIGONOMETRIC RELATIONSHIPS

(continued)

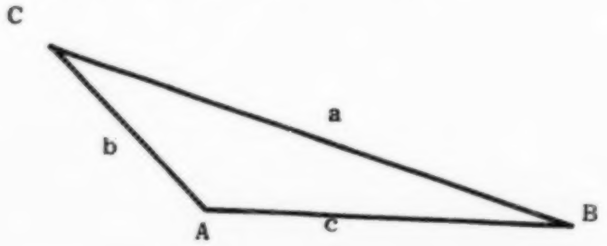
IV NUMERICAL VALUES OF SELECTED TRIGONOMETRIC FUNCTIONS

Function Angle	Sin	Cos	Tan	Cot	Sec	Csc
0°	0	1	0	$\pm\infty$	0	$\pm\infty$
30°	$\frac{1}{2}$	$\frac{1}{2}\sqrt{3}$	$\frac{1}{3}\sqrt{3}$	$\sqrt{3}$	$\frac{2}{3}\sqrt{3}$	2
45°	$\frac{1}{2}\sqrt{2}$	$\frac{1}{2}\sqrt{2}$	1	1	$\sqrt{2}$	$\sqrt{2}$
60°	$\frac{1}{2}\sqrt{3}$	$\frac{1}{2}$	$\sqrt{3}$	$\frac{1}{3}\sqrt{3}$	2	$\frac{2}{3}\sqrt{3}$
90°	1	0	$\pm\infty$	0	$\pm\infty$	1
120°	$\frac{1}{2}\sqrt{3}$	$-\frac{1}{2}$	$-\sqrt{3}$	$-\frac{1}{3}\sqrt{3}$	-2	$\frac{2}{3}\sqrt{3}$
135°	$\frac{1}{2}\sqrt{2}$	$-\frac{1}{2}\sqrt{2}$	-1	-1	$-\sqrt{2}$	$\sqrt{2}$
150°	$\frac{1}{2}$	$-\frac{1}{2}\sqrt{3}$	$-\frac{1}{3}\sqrt{3}$	$-\sqrt{3}$	$-\frac{2}{3}\sqrt{3}$	2
180°	0	-1	0	$\pm\infty$	- 1	$\pm\infty$
210°	$-\frac{1}{2}$	$-\frac{1}{2}\sqrt{3}$	$\frac{1}{3}\sqrt{3}$	$\sqrt{3}$	$-\frac{2}{3}\sqrt{3}$	-2
225°	$-\frac{1}{2}\sqrt{2}$	$-\frac{1}{2}\sqrt{2}$	1	1	$-\sqrt{2}$	$-\sqrt{2}$
240°	$-\frac{1}{2}\sqrt{3}$	$-\frac{1}{2}$	$\sqrt{3}$	$\frac{1}{3}\sqrt{3}$	- 2	$-\frac{2}{3}\sqrt{3}$
270°	-1	0	$\pm\infty$	0	$\pm\infty$	- 1
300°	$-\frac{1}{2}\sqrt{3}$	$\frac{1}{2}$	$-\sqrt{3}$	$-\frac{1}{3}\sqrt{3}$	2	$-\frac{2}{3}\sqrt{3}$
315°	$-\frac{1}{2}\sqrt{2}$	$\frac{1}{2}\sqrt{2}$	-1	-1	$\sqrt{2}$	$-\sqrt{2}$
330°	$-\frac{1}{2}$	$\frac{1}{2}\sqrt{3}$	$-\frac{1}{3}\sqrt{3}$	$-\sqrt{3}$	$\frac{2}{3}\sqrt{3}$	-2
360°	0	1	0	$\pm\infty$	1	$\pm\infty$

SELECTED TRIGONOMETRIC RELATIONSHIPS

(continued)

V SOLUTION OF ANY TRIANGLE



$$s = \frac{a+b+c}{2}$$

CASE / ITEM	I	II	III	IV
Given:	One side and two angles	Two sides and an angle opposite one of them	Two sides and their included angle	Three sides
Solution:	Law of sines	Law of sines	Law of tangents	Tangents of half angles
Check:	Law of tangents or Newton's formula	Law of tangents or Newton's formula	Law of sines or Newton's formula	$A + B + C = 180^\circ$
Area:	$\frac{a^2 \sin B \sin C}{2 \sin A}$	$\frac{ab \sin C}{2}$	$\frac{ab \sin C}{2}$	$[s(s-a)(s-b)(s-c)]^{\frac{1}{2}}$

Law of Sines: In any triangle the sides are proportional to the sines of the opposite angles.

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

Law of Cosines: The square of any two sides of a triangle is equal to the sum of the squares of the other two sides diminished by twice the product of the other two sides and their included angle.

$$a^2 = b^2 + c^2 - 2bc \cos A$$

$$b^2 = a^2 + c^2 - 2ac \cos B$$

$$c^2 = a^2 + b^2 - 2ab \cos C$$

Law of Tangents: In any triangle the tangent of half the difference of any two angles is to the tangent of half their sum as the difference of the sides opposite these angles is to their difference.

$$\frac{\tan\left(\frac{A-B}{2}\right)}{\tan\left(\frac{A+B}{2}\right)} = \frac{a-b}{a+b} \qquad \text{where } a > b$$

$$\frac{\tan\left(\frac{B-C}{2}\right)}{\tan\left(\frac{B+C}{2}\right)} = \frac{b-c}{b+c} \qquad \text{where } b > c$$

$$\frac{\tan\left(\frac{A-C}{2}\right)}{\tan\left(\frac{A+C}{2}\right)} = \frac{a-c}{a+c} \qquad \text{where } a > c$$

SELECTED TRIGONOMETRIC RELATIONSHIPS

(continued)

Tangents of Half Angles:

$$\tan\frac{A}{2} = \frac{\left[\frac{(s-a)\,(s-b)\,(s-c)}{s}\right]^{\frac{1}{2}}}{(s-a)}$$

$$\tan\frac{B}{2} = \frac{\left[\frac{(s-a)\,(s-b)\,(s-c)}{s}\right]^{\frac{1}{2}}}{(s-b)}$$

$$\tan\frac{C}{2} = \frac{\left[\frac{(s-a)\,(s-b)\,(s-c)}{s}\right]^{\frac{1}{2}}}{(s-c)}$$

Newton's Formula:

$$\frac{c}{\sin\frac{C}{2}} = \frac{a+b}{\cos\left(\frac{A-B}{2}\right)}$$

Area Formulae:

$$\text{Area} = \left[\, s(s-a)\,(s-b)\,(s-c)\right]^{\frac{1}{2}}$$

$$\text{Area} = \frac{a^2 \sin B \sin C}{2 \sin A}$$

$$\text{Area} = \frac{b^2 \sin A \sin C}{2 \sin B}$$

$$\text{Area} = \frac{c^2 \sin A \sin B}{2 \sin C}$$

$$\text{Area} = \tfrac{1}{2} bc \sin A$$

$$\text{Area} = \tfrac{1}{2} ac \sin B$$

$$\text{Area} = \tfrac{1}{2} ab \sin C$$

SELECTED PRINCIPLES OF GRAPHICS

I THE STRAIGHT LINE (RECTANGULAR COORDINATE SYSTEM)

A Distance Between any Two Points

$$\overline{P_1P_2} = \left[(x_2 - x_1)^2 + (y_2 - y_1)^2\right]^{\frac{1}{2}}$$

B Coordinates of the Midpoint of a Line

$$x = \frac{x_1 + x_2}{2}, \quad y = \frac{y_1 + y_2}{2}$$

C Slope of a Line

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

D Angle of Intersection of Two Lines

$$\tan \phi_{1 \longrightarrow 2} = \frac{m_2 - m_1}{1 + m_1 m_2}$$

E Forms of Equations of Straight Lines

1 Equation of a line through a given point with given slope

a Any point; any slope

$$y - y_1 = m(x - x_1)$$

b Origin; any slope

$$y = mx$$

2 Equation of a line through two given points

$$y - y_1 = \frac{y_2 - y_1}{x_2 - x_1}\left(x - x_1\right)$$

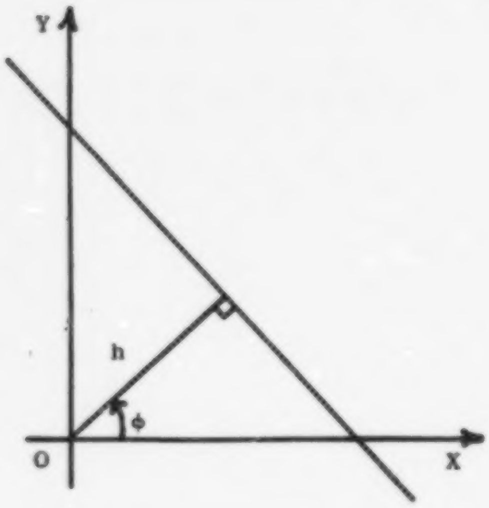
3 Equation of a line through a given Y-intercept with a given slope.

$$y = mx + b$$

4 Equation of a line through its intercepts on both axes.

$$\frac{x}{a} + \frac{y}{b} = 1$$

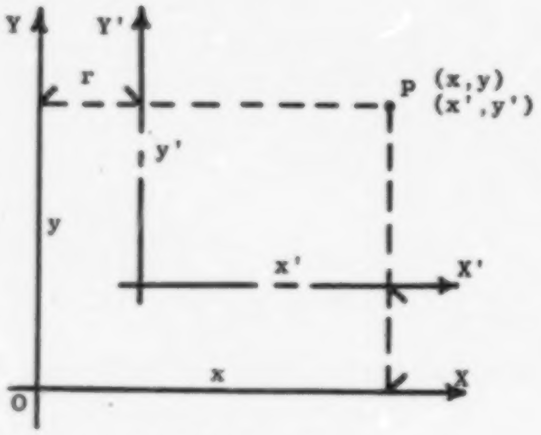
5 Equation of a line in terms of the perpendicular distance to a line from the origin and the positive angle which the perpendicular makes with the X-axis.



$$x \cos \phi + y \sin \phi = h$$

II ADJUSTING THE AXES

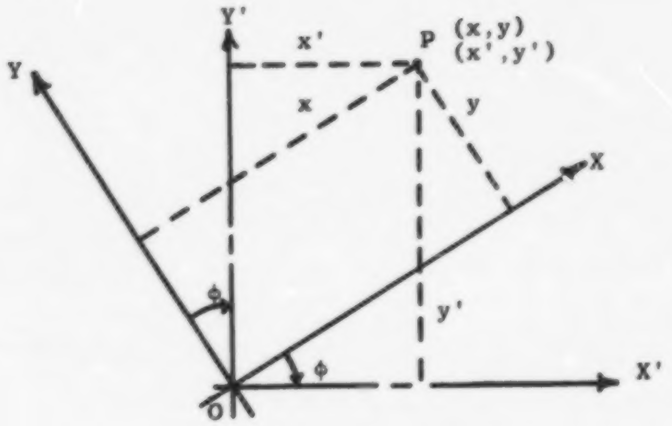
A Translation of Axes



$$x' = x - r \text{ and } y' = y - s$$

SELECTED PRINCIPLES OF GRAPHICS
(continued)

B Rotation of Axes



$$x' = x \cos \phi - y \sin \phi$$

$$y' = x \sin \phi + y \cos \phi$$

III EQUATIONS OF COMMON GEOMETRIC FORMS

A Circle

$$x^2 + y^2 + Ax + By + C = 0$$

$$(x - h)^2 + (y - k)^2 = r^2$$

$x^2 + y^2 = r^2$ (center of circle at origin)

B Ellipse

$Ax^2 + By^2 + Cx + Dy + E = 0$ (A & B have the same sign)

$$\frac{(x - h)^2}{a^2} + \frac{(y - k)^2}{b^2} = 1$$

$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ (center of ellipse at origin)

C Parabola

$$Ax^2 + Bx + Cy + D = 0$$

$$(x - h)^2 = 2p(y - k)$$

$x^2 = 2py$ (vertex of parabola at origin)

D Hyperbola

$Ax^2 + By^2 + Cx + Dy + E = 0$ (A & B have opposite signs)

$$\frac{(x - h)^2}{a^2} - \frac{(y - k)^2}{b^2} = 1$$

$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ (center of hyperbola at origin)

E Summary

$$Ax^2 + By^2 + Cx + Dy + E = 0$$

1 If A = B, the curve will be a circle.

2 If either A or B equal 0, the curve will be a parabola.

3 If A and B have the same sign and $A \neq B$, the curve is an ellipse.

4 If A and B have opposite signs, the curve is a hyperbola.

SELECTED INTEGRALS

1 $\int 0dx = c$

2 $\int dx = x + c$

3 $\int adx = ax + c$

4 $\int x^n dx = \frac{x^{n+1}}{n+1} + c$ where $n \neq -1$

5 $\int \frac{dx}{x} = \ln x + c$

6 $\int e^x dx = e^x + c$

7 $\int a^x dx = \frac{a^x}{\ln x} + c$

8 $\int \sin x \, dx = -\cos x + c$

9 $\int \cos x \, dx = \sin x + c$

10 $\int \tan x \, dx = \ln \sec x + c$

11 $\int \cot x \, dx = \ln \sin x + c$

12 $\int \sec x \, dx = \ln(\sec x + \tan x) + c$

13 $\int \csc x \, dx = \ln(\csc x - \cot x) + c$

14 $\int \sec^2 x \, dx = \tan x + c$

15 $\int \csc^2 x \, dx = -\cot x + c$

16 $\int \sec x \tan x \, dx = \sec x + c$

17 $\int \csc x \cot x \, dx = -\csc x + c$

18 $\int \frac{dx}{(a^2 - x^2)^{\frac{1}{2}}} = \text{arc} \sin \frac{x}{a} + c$

19 $\int \frac{dx}{a^2 + x^2} = \frac{1}{a} \text{arc} \tan \frac{x}{a} + c$

20 $\int \frac{dx}{x(x^2 - a^2)^{\frac{1}{2}}} = \frac{1}{a} \text{arc} \sec \frac{x}{a} + c$

21 $\int \frac{dx}{x^2 - a^2} = \frac{1}{2a} \ln \left(\frac{x - a}{x + a}\right) + c$

22 $\int \frac{dx}{a^2 - x^2} = \frac{1}{2a} \ln \left(\frac{a + x}{a - x}\right) + c$

23 $\int \frac{dx}{(x^2 \pm a^2)^{\frac{1}{2}}} = \ln \left[x + (x^2 \pm a^2)^{\frac{1}{2}}\right] + c$

24 $\int (a^2 - x^2)^{\frac{1}{2}} dx = \frac{x}{2} (a^2 - x^2)^{\frac{1}{2}} + \frac{a^2}{2} \text{arc} \sin \frac{x}{a} + c$

25 $\int (x^2 \pm a^2)^{\frac{1}{2}} dx = \frac{x}{2}(x^2 \pm a^2)^{\frac{1}{2}} \pm \frac{a^2}{2} \ln \left[x + (x^2 \pm a^2)^{\frac{1}{2}}\right] + c$

26 $\int \sin^2 x \, dx = \frac{x}{2} - \frac{1}{4} \sin 2x + c$

27 $\int \sin^3 x \, dx = -\frac{1}{3} \cos x \, (\sin^2 x + 2) + c$

28 $\int \sin^n x \, dx = -\frac{\sin^{n-1} x \cos x}{n} + \frac{n-1}{n} \int \sin^{n-2} x \, dx$

29 $\int \cos^2 x \, dx = \frac{x}{2} + \frac{1}{4} \sin 2x + c$

30 $\int \cos^3 x \, dx = \frac{1}{3} \sin x \, (\cos^2 x + 2) + c$

31 $\int \cos^n x \, dx = \frac{\cos^{n-1} x \sin x}{n} + \frac{n-1}{n} \int \cos^{n-2} x \, dx$

32 $\int \tan^n x \, dx = \frac{\tan^{n-1} x}{n-1} - \int \tan^{n-2} x \, dx$

33 $\int \cot^n x \, dx = -\frac{\cot^{n-1} x}{n-1} - \int \cot^{n-2} x \, dx$

34 $\int \sec^n x \, dx = \frac{\sin x}{(n-1)\cos^{n-1} x} + \frac{n-2}{n-1} \int \sec^{n-2} x \, dx$

35 $\int \csc^n x \, dx = -\frac{\cos x}{(n-1)\sin^{n-1} x} + \frac{n-2}{n-1} \int \csc^{n-2} x \, dx$

36 $\int x \sin x \, dx = \sin x - x \cos x + c$

37 $\int x \cos x \, dx = \cos x + x \sin x + c$

38 $\int \sin x \cos x \, dx = \frac{1}{2} \sin^2 x + c$

39 $\int \text{arc} \sin x \, dx = x \, \text{arc} \sin x + (1-x^2)^{\frac{1}{2}} + c$

40 $\int \text{arc} \cos x \, dx = x \, \text{arc} \cos x - (1-x^2)^{\frac{1}{2}} + c$

41 $\int \text{arc} \tan x \, dx = x \, \text{arc} \tan x - \frac{1}{2} \ln (1+x^2) + c$

42 $\int \text{arc} \cot x \, dx = x \, \text{arc} \cot x + \frac{1}{2} \ln (1+x^2) + c$

43 $\int \text{arc} \sec x \, dx = x \, \text{arc} \sec x - \ln \left[x + (x^2-1)^{\frac{1}{2}}\right] + c$

44 $\int \text{arc} \csc x \, dx = x \, \text{arc} \csc x + \ln \left[x + (x^2-1)^{\frac{1}{2}}\right] + c$

SELECTED DIFFERENTIALS

Function	Derivative	Function	Derivative
1 $y = c$	$\frac{dy}{dx} = 0$	14 $y = u^v$	$\frac{dy}{dx} = vu^{v-1}\frac{du}{dx} + u^v \ln u \frac{dv}{dx}$
2 $y = x$	$\frac{dy}{dx} = 1$	15 $y = \sin u$	$\frac{dy}{dx} = \cos u \frac{du}{dx}$
3 $y = ax$	$\frac{dy}{dx} = a$	16 $y = \cos u$	$\frac{dy}{dx} = - \sin u \frac{du}{dx}$
4 $y = x^n$	$\frac{dy}{dx} = nx^{n-1}$	17 $y = \tan u$	$\frac{dy}{dx} = \sec^2 u \frac{du}{dx}$
5 $y = u + v$	$\frac{dy}{dx} = \frac{du}{dx} + \frac{dv}{dx}$	18 $y = \cot u$	$\frac{dy}{dx} = - \csc^2 u \frac{du}{dx}$
6 $y = uv$	$\frac{dy}{dx} = u\frac{dv}{dx} + v\frac{du}{dx}$	19 $y = \sec u$	$\frac{dy}{dx} = \sec u \tan u \frac{du}{dx}$
7 $y = \frac{u}{v}$	$\frac{dy}{dx} = \frac{v\frac{du}{dx} - u\frac{dv}{dx}}{v^2}$	20 $y = \csc u$	$\frac{dy}{dx} = - \csc u \cot u \frac{du}{dx}$
8 $y = f(u),\ u = f(x)$	$\frac{dy}{dx} = \frac{dy}{du} \cdot \frac{du}{dx}$	21 $y = \text{arc} \sin u$	$\frac{dy}{dx} = \frac{1}{(1 - u^2)^{\frac{1}{2}}} \frac{du}{dx}$
9 $y = u^n$	$\frac{dy}{dx} = nu^{n-1}\frac{du}{dx}$	22 $y = \text{arc} \cos u$	$\frac{dy}{dx} = \frac{-1}{(1 - u^2)^{\frac{1}{2}}} \frac{du}{dx}$
10 $y = \log_a u$	$\frac{dy}{dx} = \frac{1}{u} \log_a e \frac{du}{dx}$	23 $y = \text{arc} \tan u$	$\frac{dy}{dx} = \frac{1}{1 + u^2} \frac{du}{dx}$
11 $y = \ln u$	$\frac{dy}{dx} = \frac{1}{u} \frac{du}{dx}$	24 $y = \text{arc} \cot u$	$\frac{dy}{dx} = \frac{-1}{1 + u^2} \frac{du}{dx}$
12 $y = a^u$	$\frac{dy}{dx} = a^u \ln a \frac{du}{dx}$	25 $y = \text{arc} \sec u$	$\frac{dy}{dx} = \frac{1}{u(u^2 - 1)^{\frac{1}{2}}} \frac{du}{dx}$
13 $y = e^u$	$\frac{dy}{dx} = e^u \frac{du}{dx}$	26 $y = \text{arc} \csc u$	$\frac{dy}{dx} = \frac{-1}{u(u^2 - 1)^{\frac{1}{2}}} \frac{du}{dx}$

STATISTICAL ANALYSIS OF THE FREQUENCY DISTRIBUTION

I STATISTICS USED TO DETERMINE CENTRAL TENDENCY

A Arithmetic Mean

1 Ungrouped data

$$\bar{x} = \frac{x_1 + x_2 + x_3 \ldots + x_n}{n} = \frac{\Sigma x}{n}$$

2 Grouped data

$$\bar{x} = \frac{\Sigma(f \times MP)}{N}$$

B Median

1 Ungrouped data

$$\text{median} = \left(\frac{N+1}{2}\right)^{th} \text{term}$$

2 Grouped data

$$\text{median} = L + \frac{iC}{f}$$

C Mode

1 Ungrouped data

mode = most frequent value

2 Grouped data

$$\text{mode (approximation)} = L + \left(\frac{f_a}{f_a + f_b}\right) C$$

D Geometric Mean

1 Ungrouped data

$$G_m = \left[(x_1)(x_2) \ldots (x_n)\right]^{\frac{1}{N}}$$

or

$$\log G_m = \frac{\log x_1 + \log x_2 \ldots + \log x_N}{N}$$

2 Grouped data

$$\log G_m = \frac{\Sigma(f \times \log MP)}{N}$$

II STATISTICS USED TO DETERMINE DISPERSION OF RESULTS

A Range

$$R = x_{max} - x_{min}$$

B Average Deviation

1 Ungrouped data

$$AD = \frac{\Sigma(x - \bar{x})}{N}$$

2 Grouped data

$$AD = \frac{\Sigma f(MP - \bar{x})}{N}$$

C Standard Deviation

1 Ungrouped data

$$s = \left[\frac{\Sigma(x - \bar{x})^2}{N - 1}\right]^{\frac{1}{2}}$$

2 Grouped data

$$s = \left[\frac{\Sigma f(MP - \bar{x})^2}{N - 1}\right]^{\frac{1}{2}}$$

correction for grouping

$$s^2 = \left(s'^2 - \frac{1}{12}\right) C^2$$

3 Value of the standard deviation

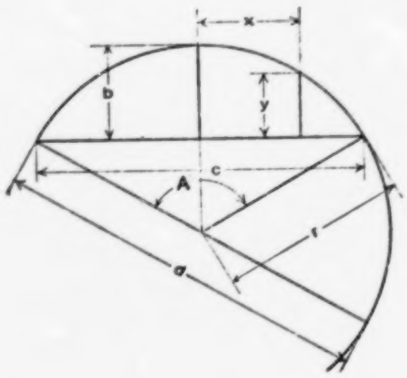
$\bar{x} \pm 1s$ contains 68.3% of the area under the normal curve

$\bar{x} \pm 2s$ contains 95.5% of the area under the normal curve

$\bar{x} \pm 3s$ contains 99.8% of the area under the normal curve.

PROPERTIES OF SELECTED GEOMETRIC FIGURES

PROPERTIES OF THE CIRCLE



Circumference $= 6.28318\ r = 3.14159\ d$

Diameter $= 0.31831$ circumference

Area $= 3.14159\ r^2$

Arc $a = \dfrac{\pi r A^\circ}{180^\circ} = 0.017453\ r A^\circ$

Angle $A^\circ = \dfrac{180^\circ a}{\pi r} = 57.29578 \dfrac{a}{r}$

Radius $r = \dfrac{4b^2 + c^2}{8b}$

Chord $c = 2\sqrt{2br - b^2} = 2r \sin\dfrac{A}{2}$

Rise $b = r - \tfrac{1}{2}\sqrt{4r^2 - c^2} = \dfrac{c}{2}\tan\dfrac{A}{4}$

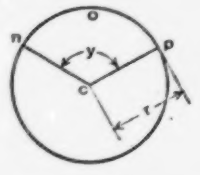
$= 2r\sin^2\dfrac{A}{4} = r + y - \sqrt{r^2 - x^2}$

$y = b - r + \sqrt{r^2 - x^2}$

$x = \sqrt{r^2 - (r + y - b)^2}$

Diameter of circle of equal periphery as square = 1.27324 side of square
Side of square of equal periphery as circle = 0.78540 diameter of circle
Diameter of circle circumscribed about square = 1.41421 side of square
Side of square inscribed in circle = 0.70711 diameter of circle

CIRCULAR SECTOR



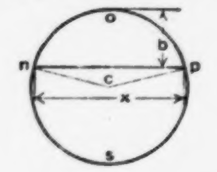
r = radius of circle   y = angle ncp in degrees

Area of Sector ncpo = ½ (length of arc nop × r)

$= \text{Area of Circle} \times \dfrac{y}{360}$

$= 0.0087266 \times r^2 \times y$

CIRCULAR SEGMENT



r = radius of circle   x = chord   b = rise

Area of Segment nop = Area of Sector ncpo — Area of triangle ncp

$= \dfrac{(\text{Length of arc nop} \times r) - x\,(r - b)}{2}$

Area of Segment nsp = Area of Circle — Area of Segment nop

VALUES FOR FUNCTIONS OF π

$\pi = 3.14159265359, \quad \log = 0.4971499$

$\pi^2 = 9.8696044, \log = 0.9942997$ $\quad \dfrac{1}{\pi} = 0.3183099, \log = \overline{1}.5028501$ $\quad \sqrt{\dfrac{1}{\pi}} = 0.5641896, \log = \overline{1}.7514251$

$\pi^3 = 31.0062767, \log = 1.4914496$ $\quad \dfrac{1}{\pi^2} = 0.1013212, \log = \overline{1}.0057003$ $\quad \dfrac{\pi}{180} = 0.0174533, \log = \overline{2}.2418774$

$\sqrt{\pi} = 1.7724539, \log = 0.2485749$ $\quad \dfrac{1}{\pi^3} = 0.0322515, \log = \overline{2}.5085500$ $\quad \dfrac{180}{\pi} = 57.2957795, \log = 1.7581226$

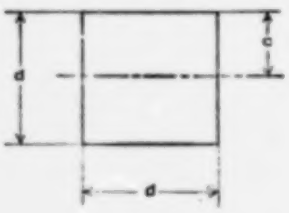
See Reference No. 4

PROPERTIES OF SELECTED GEOMETRIC FIGURES
(continued)

PROPERTIES OF GEOMETRIC SECTIONS

SQUARE

Axis of moments through center



$A = d^2$

$c = \frac{d}{2}$

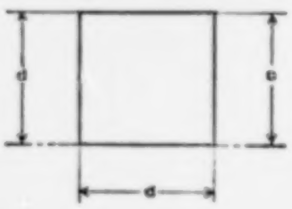
$I = \frac{d^4}{12}$

$S = \frac{d^3}{6}$

$r = \frac{d}{\sqrt{12}} = .288675\ d$

SQUARE

Axis of moments on base



$A = d^2$

$c = d$

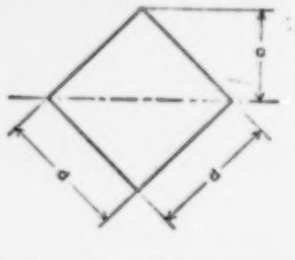
$I = \frac{d^4}{3}$

$S = \frac{d^3}{3}$

$r = \frac{d}{\sqrt{3}} = .577350\ d$

SQUARE

Axis of moments on diagonal



$A = d^2$

$c = \frac{d}{\sqrt{2}} = .707107\ d$

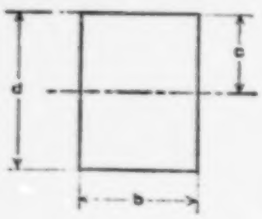
$I = \frac{d^4}{12}$

$S = \frac{d^3}{6\sqrt{2}} = .117851\ d^3$

$r = \frac{d}{\sqrt{12}} = .288675\ d$

RECTANGLE

Axis of moments through center



$A = bd$

$c = \frac{d}{2}$

$I = \frac{bd^3}{12}$

$S = \frac{bd^2}{6}$

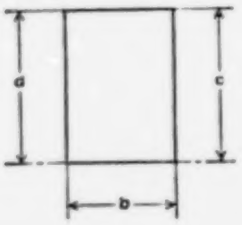
$r = \frac{d}{\sqrt{12}} = .288675\ d$

PROPERTIES OF SELECTED GEOMETRIC FIGURES
(continued)

PROPERTIES OF GEOMETRIC SECTIONS

RECTANGLE

Axis of moments on base



$A = bd$

$c = d$

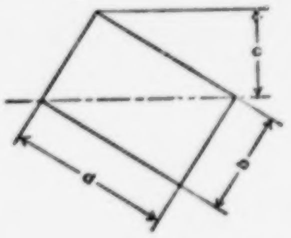
$I = \frac{bd^3}{3}$

$S = \frac{bd^2}{3}$

$r = \frac{d}{\sqrt{3}} = .577350\,d$

RECTANGLE

Axis of moments on diagonal



$A = bd$

$c = \frac{bd}{\sqrt{b^2 + d^2}}$

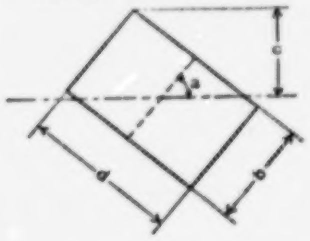
$I = \frac{b^3d^3}{6\,(b^2 + d^2)}$

$S = \frac{b^2d^2}{6\sqrt{b^2 + d^2}}$

$r = \frac{bd}{\sqrt{6\,(b^2 + d^2)}}$

RECTANGLE

Axis of moments any line through center of gravity



$A = bd$

$c = \frac{b \sin a + d \cos a}{2}$

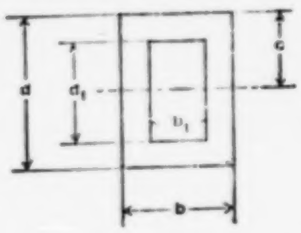
$I = \frac{bd\,(b^2 \sin^2 a + d^2 \cos^2 a)}{12}$

$S = \frac{bd\,(b^2 \sin^2 a + d^2 \cos^2 a)}{6\,(b \sin a + d \cos a)}$

$r = \sqrt{\frac{b^2 \sin^2 a + d^2 \cos^2 a}{12}}$

HOLLOW RECTANGLE

Axis of moments through center



$A = bd - b_1d_1$

$c = \frac{d}{2}$

$I = \frac{bd^3 - b_1d_1^3}{12}$

$S = \frac{bd^3 - b_1d_1^3}{6d}$

$r = \sqrt{\frac{bd^3 - b_1d_1^3}{12\,A}}$

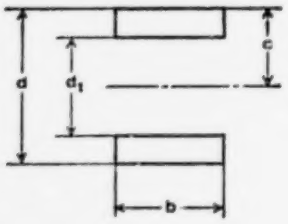
PROPERTIES OF SELECTED GEOMETRIC FIGURES

(continued)

PROPERTIES OF GEOMETRIC SECTIONS

EQUAL RECTANGLES

Axis of moments through center of gravity



$$A = b(d - d_1)$$

$$c = \frac{d}{2}$$

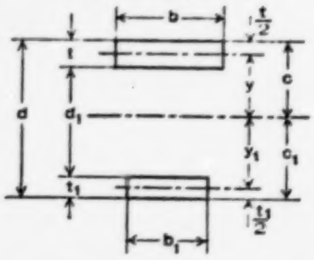
$$I = \frac{b(d^3 - d_1^3)}{12}$$

$$S = \frac{b(d^3 - d_1^3)}{6d}$$

$$r = \sqrt{\frac{d^3 - d_1^3}{12(d - d_1)}}$$

UNEQUAL RECTANGLES

Axis of moments through center of gravity



$$A = bt + b_1t_1$$

$$c = \frac{\frac{1}{2}bt^2 + b_1t_1(d - \frac{1}{2}t_1)}{A}$$

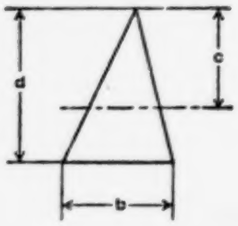
$$I = \frac{bt^3}{12} + bty^2 + \frac{b_1t_1^3}{12} + b_1t_1y_1^2$$

$$S = \frac{I}{c} \qquad S_1 = \frac{I}{c_1}$$

$$r = \sqrt{\frac{I}{A}}$$

TRIANGLE

Axis of moments through center of gravity



$$A = \frac{bd}{2}$$

$$c = \frac{2d}{3}$$

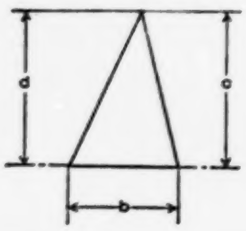
$$I = \frac{bd^3}{36}$$

$$S = \frac{bd^2}{24}$$

$$r = \frac{d}{\sqrt{18}} = .235702\,d$$

TRIANGLE

Axis of moments on base



$$A = \frac{bd}{2}$$

$$c = d$$

$$I = \frac{bd^3}{12}$$

$$S = \frac{bd^2}{12}$$

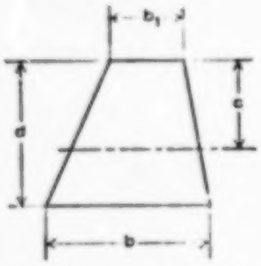
$$r = \frac{d}{\sqrt{6}} = .408248\,d$$

PROPERTIES OF SELECTED GEOMETRIC FIGURES
(continued)

PROPERTIES OF GEOMETRIC SECTIONS

TRAPEZOID

Axis of moments through center of gravity



$$A = \frac{d(b + b_1)}{2}$$

$$c = \frac{d(2b + b_1)}{3(b + b_1)}$$

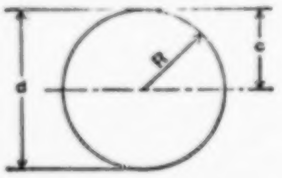
$$I = \frac{d^3 (b^2 + 4\,bb_1 + b_1^2)}{36\,(b + b_1)}$$

$$S = \frac{d^2 (b^2 + 4\,bb_1 + b_1^2)}{12\,(2b + b_1)}$$

$$r = \frac{d}{6(b + b_1)} \sqrt{2\,(b^2 + 4\,bb_1 + b_1^2)}$$

CIRCLE

Axis of moments through center



$$A = \frac{\pi d^2}{4} = \pi R^2 = .785398\, d^2 = 3.141593\, R^2$$

$$c = \frac{d}{2} = R$$

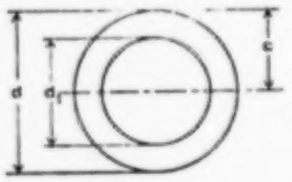
$$I = \frac{\pi d^4}{64} = \frac{\pi R^4}{4} = .049087\, d^4 = .785398\, R^4$$

$$S = \frac{\pi d^3}{32} = \frac{\pi R^3}{4} = .098175\, d^3 = .785398\, R^3$$

$$r = \frac{d}{4} = \frac{R}{2}$$

HOLLOW CIRCLE

Axis of moments through center



$$A = \frac{\pi(d^2 - d_1^2)}{4} = .785398\,(d^2 - d_1^2)$$

$$c = \frac{d}{2}$$

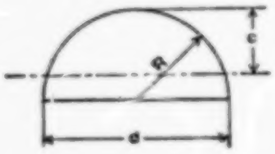
$$I = \frac{\pi(d^4 - d_1^4)}{64} = .049087\,(d^4 - d_1^4)$$

$$S = \frac{\pi(d^4 - d_1^4)}{32d} = .098175\, \frac{d^4 - d_1^4}{d}$$

$$r = \frac{\sqrt{d^2 + d_1^2}}{4}$$

HALF CIRCLE

Axis of moments through center of gravity



$$A = \frac{\pi R^2}{2} = 1.570796\, R^2$$

$$c = R\left(1 - \frac{4}{3\pi}\right) = .575587\, R$$

$$I = R^4\left(\frac{\pi}{8} - \frac{8}{9\pi}\right) = .109757\, R^4$$

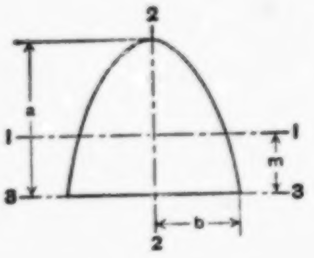
$$S = \frac{R^3}{24}\,\frac{(9\pi^2 - 64)}{(3\pi - 4)} = .190687\, R^3$$

$$r = R\,\frac{\sqrt{9\pi^2 - 64}}{6\pi} = .264336\, R$$

PROPERTIES OF SELECTED GEOMETRIC FIGURES
(continued)

PROPERTIES OF GEOMETRIC SECTIONS

PARABOLA



$A = \frac{4}{3} ab,$

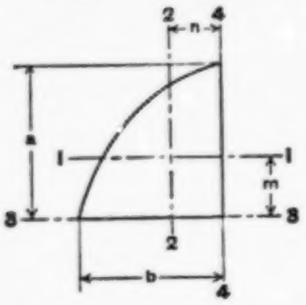
$m = \frac{2}{5} a$

$I_1 = \frac{16}{175} a^3 t$

$I_2 = \frac{4}{15} ab^3$

$I_3 = \frac{32}{105} a^3 b$

HALF PARABOLA



$A = \frac{2}{3} ab$

$m = \frac{2}{5} a$

$n = \frac{3}{8} b$

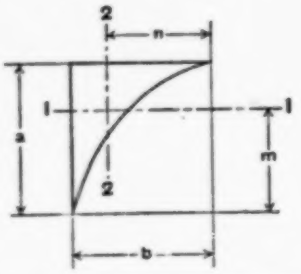
$I_1 = \frac{8}{175} a^3 b$

$I_2 = \frac{19}{480} ab^3$

$I_3 = \frac{16}{105} a^3 b$

$I_4 = \frac{2}{15} ab^3$

COMPLEMENT OF HALF PARABOLA



$A = \frac{1}{3} ab$

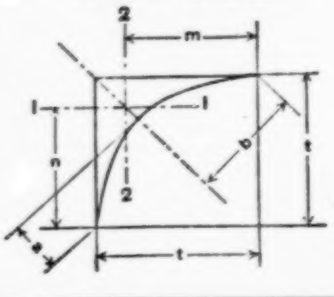
$m = \frac{7}{10} a$

$n = \frac{3}{4} b$

$I_1 = \frac{37}{2100} a^3 b$

$I_2 = \frac{1}{80} ab^3$

PARABOLIC FILLET IN RIGHT ANGLE



$a = \frac{t}{2\sqrt{2}}$

$b = \frac{t}{\sqrt{2}}$

$A = \frac{1}{6} t^2$

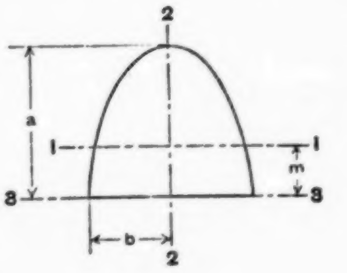
$m = n = \frac{4}{5} t$

$I_1 = I_2 = \frac{11}{2100} t^4$

PROPERTIES OF SELECTED GEOMETRIC FIGURES
(continued)

PROPERTIES OF GEOMETRIC SECTIONS

* HALF ELLIPSE



$$A = \frac{1}{2}\pi ab$$

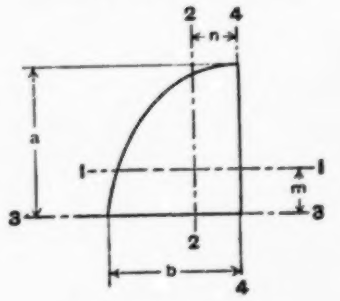
$$m = \frac{4a}{3\pi}$$

$$I_1 = a^3b\left(\frac{\pi}{8} - \frac{8}{9\pi}\right)$$

$$I_2 = \frac{1}{8}\pi ab^3$$

$$I_3 = \frac{1}{8}\pi a^3b$$

* QUARTER ELLIPSE



$$A = \frac{1}{4}\pi ab$$

$$m = \frac{4a}{3\pi}$$

$$n = \frac{4b}{3\pi}$$

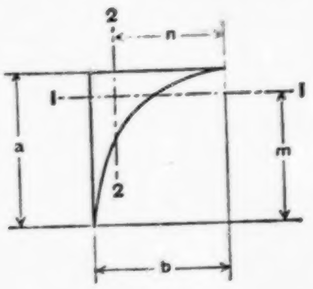
$$I_1 = a^3b\left(\frac{\pi}{16} - \frac{4}{9\pi}\right)$$

$$I_2 = ab^3\left(\frac{\pi}{16} - \frac{4}{9\pi}\right)$$

$$I_3 = \frac{1}{16}\pi a^3b$$

$$I_4 = \frac{1}{16}\pi ab^3$$

* ELLIPTIC COMPLEMENT



$$A = ab\left(1 - \frac{\pi}{4}\right)$$

$$m = \frac{a}{6\left(1 - \frac{\pi}{4}\right)}$$

$$n = \frac{b}{6\left(1 - \frac{\pi}{4}\right)}$$

$$I_1 = a^3b\left(\frac{1}{3} - \frac{\pi}{16} - \frac{1}{36\left(1 - \frac{\pi}{4}\right)}\right)$$

$$I_2 = ab^3\left(\frac{1}{3} - \frac{\pi}{16} - \frac{1}{36\left(1 - \frac{\pi}{4}\right)}\right)$$

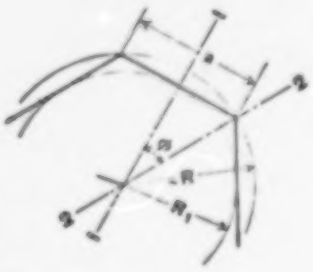
* To obtain properties of half circle, quarter circle and circular complement substitute $a = b = R$.

PROPERTIES OF SELECTED GEOMETRIC FIGURES
(continued)

PROPERTIES OF GEOMETRIC SECTIONS

REGULAR POLYGON

Axis of moments through center



n = Number of sides

$$\phi = \frac{180^\circ}{n}$$

$$a = 2\sqrt{R^2 - R_1^2}$$

$$R = \frac{a}{2\sin\phi}$$

$$R_1 = \frac{a}{2\tan\phi}$$

$$A = \frac{1}{4}na^2\cot\phi = \frac{1}{2}nR^2\sin 2\phi = nR_1^2\tan\phi$$

$$I_1 = I_2 = \frac{A(6R^2 - a^2)}{24} = \frac{A(12R_1^2 + a^2)}{48}$$

$$r_1 = r_2 = \sqrt{\frac{6R^2 - a^2}{24}} = \sqrt{\frac{12R_1^2 + a^2}{48}}$$

SECTION 18 BIBLIOGRAPHY

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NOTE: Any material which has not been assigned a reference number was developed by the Air Pollution Training Staff

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